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Soviet-French Mission to 'Mir' Scheduled for Launch

18660074a Moscow SOVETSKAYA ROSSIYA in Russian 11 Nov 88 p 6

[Article by A. Makhov and A. Nemov]

[Excerpt] On 26 November, a joint Soviet-French crew in the spaceship "Soyuz TM-7" will leave the Baykonur Cosmodrome for the orbiting complex "Mir"—"Kvant"—"Soyuz TM-6." This was announced at a press conference held in Moscow yesterday.

Pilot-cosmonaut of the USSR A. Volkov noted that the upcoming Soviet-French mission will be a natural continuation of the previous one, which took place six years ago. The French cosmonaut will work in orbit for a month, after which he will return to Earth with the two long-time occupants of the space complex—M. Manarov and V. Titov. This is to happen on 21 December.

Commenting on the upcoming experiments, J.-L. Chretien noted that France has long been cooperating with the USSR both in the field of manned flights and in other space programs. Laser ranging of the moon has been conducted with the aid of French equipment, for example, which has made it possible to determine parameters of the moon's orbit more precisely. Work is now in progress on preparing a project called "Mars-1994," which will become a continuation of the "Phobos" project.

Costs for Soviet-French Mission

18660074b Moscow IZVESTIYA in Russian 11 Nov 88 p 1

[Article by B. Konovalov, correspondent]

[Excerpt] On 10 November 1988, Soviet-French space crews were introduced to journalists at the press center of the USSR Ministry of Foreign Affairs, and the crews' first press conference took place here.

A.I. Dunayev, head of the USSR Main Administration for Development and Use of Space Technology for the Economy and Scientific Research, expressed satisfaction with the progress of Soviet-French space cooperation, which is 22 years old. During the years immediately ahead, nine more space projects are supposed to be carried out with the participation of the USSR and France. In response to questions about the commercial aspect of the "Aragats" project (the upcoming launch), A.I. Dunayev said that the French cosmonaut's mission will cost the Soviet side roughly 21 million dollars. The French side will reimburse the Soviet side for approximately 10 percent of these expenditures. Soviet specialists' stays in France have been paid for; moreover, French scientific equipment will be used by Soviet cosmonauts in the future.

The French cosmonauts began training as members of crews on 1 February 1988. The first crew's flight engineer became ill after beginning training and was replaced in March by Sergey Krikalev.

Vladimir Titov, Musa Manarov and Valeriy Polyakov, the masters of the orbiting house, are already preparing to greet the guests. All of the necessary equipment for carrying out the "Aragats" project was delivered to the station by a "Progress" cargo spaceship in September.

The Soviet cosmonauts arriving on "Mir" and V. Polyakov will work together for five months in all. It is proposed to dock the first module for further equipping of "Mir" with the orbiting complex at the end of their mission. Space will be added to the station. The new module will have a convenient hatch for egresses into open space.

Biomedical Research Program for Mission

18660074c Moscow GUDOK in Russian 18 Nov 88 p 4

[Article by M. Chernyshov]

[Excerpt] A Soviet-French crew will leave for the orbiting station "Mir" at the end of November.

In the opinion of Anatoliy Grigoryev, an eminent specialist in the field of space medicine, the medical-biological portion of the program for this mission will become a logical continuation of research which was carried out during the first [Soviet-French] expedition. At that time, important information on features of the operation of the human cardiovascular system in conditions of weightlessness was obtained on "Salyut-7" with the aid of a French instrument called "Ekhograf." In the biological experiments "Tsitos-2" and "Bioblok-3," changes were determined which microorganisms undergo when they are exposed to the effects not only of zero gravity but also of heavy charged particles which arrive in near-Earth space from deep space. "During the upcoming mission, we shall try to investigate in greater detail, using an improved 'Ekhograf' instrument, the so-called space form of motion sickness which a substantial portion of cosmonauts experience to one degree or another," noted Anatoliy Grigoryev. "New equipment and new methodological approaches will be used in radiobiological and psychophysiological research and in the study of phosphoric and calcium metabolism."

In all, 10 major series of experiments are planned in line with the program "Aragats" (the Soviet-French project was so named in honor of the mountain in Armenia where the program of joint research was worked out two

years ago). These experiments are designed to consume approximately 160 of the working hours of the "Mir" station's visiting and primary crews.

Primary and Backup Crews Named

18660074d Moscow KRASNAYA ZVEZDA in Russian 25 Nov 88 p 1

[Article by M. Rebrov, Colonel, special correspondent at Baykonur]

[Excerpt] Only hours remain until the launch of the spaceship "Soyuz TM-7," which will deliver a Soviet-French expedition to the "Mir" station where V. Titov, M. Manarov and V. Polyakov are working.

Although the state commission did not make its final decision as to the primary and back-up crews until the day before the launch, Jacques-Louis Lions, president of France's National Center for Space Research, told journalists a month ago: "The choice has been made. Jean-Loup Chretien will go on the mission."

Colonel Aleksandr Volkov, engineer Sergey Krikalev and General Jean-Loup Chretien will thus occupy the pilots' seats in "Soyuz TM-7." The second crew, which has undergone the same amount of training on land and water and flight training, will work at the Flight Control Center while their colleagues and friends are in orbit. This crew consists of Colonel Aleksandr Viktorenko, engineer Aleksandr Serebrov and Lieutenant-Colonel Michel Tognini, a test pilot of the French Air Force.

(A photograph is given showing Krikalev, Chretien, Viktorenko, Tognini, Serebrov and Volkov, who is signing a document.)

Biosketches of Cosmonauts Volkov, Krikalev, and Chretien

18660074e Moscow PRAVDA in Russian 27 Nov 88 p 1

[Text] Pilot-cosmonaut of the USSR Aleksandr Aleksandrovich Volkov, Hero of the Soviet Union, was born on 27 May 1948 in the city of Gorlovka, Donetsk Oblast.

After graduating from the Kharkov Higher Military Aviation School for Pilots imeni-Gritsevets in 1970, he served as a pilot-instructor in the Air Force. He has the qualifications "Military Pilot 1st Class" and "Test-Pilot 2nd Class."

A.A. Volkov has been a member of the Communist Party of the Soviet Union since 1973.

He has been in the cosmonaut contingent since 1976. Aleksandr Aleksandrovich carried out his first space mission in 1985 on board the spaceship "Soyuz T-14" and the orbiting station "Salyut-7." He has received the qualification "Cosmonaut 3rd Class."

A.A. Volkov is now taking a correspondence course at the Military Political Academy imeni Lenin.

Sergey Konstantinovich Krikalev was born in Leningrad on 27 August 1958.

After graduating from the Leningrad Mechanical Institute in 1981, he worked in a design bureau. While working there, he proved himself to be a highly qualified specialist. He took part in development of new models of space technology.

S.K. Krikalev is a master of sports of the USSR for airplane sport, and he has mastered several types of sports airplanes.

Sergey Konstantinovich began to train for space flights in 1985. He has passed a complete course of training for flights on "Soyuz TM" spaceships and the orbiting complex "Mir."

Jean-Loup Chretien, Hero of the Soviet Union and a citizen of the French Republic, was born on 20 August 1938, in the city of La Rochelle.

After graduating from an air force school, Jean-Loup Chretien served as a fighter-pilot in the French Air Force from 1962, and he did testing work from 1970. He was appointed deputy Air Force commander for the southern region of France in 1977.

Jean-Loup Chretien arrived for training at the Cosmonaut Training Center imeni Gagarin in 1980. He carried out his first mission in June of 1982 on board the spaceship "Soyuz T-6" and the orbiting station "Salyut-7."

Jean-Loup Chretien has been a flight director of France's National Center for Space Research since 1982.

Jean-Loup Chretien began to train for his second space mission in November of 1986.

Background of Cosmonaut Sergey Krikalev

18660074f Moscow IZVESTIYA in Russian 22 Nov 88 p 3

[Article by Boris Konovalov]

[Extract] Two crews are now at the Baykonur Cosmodrome preparing for a Soviet-French manned flight. The final decision as to which of these threesomes will go into space will be made by the state commission on the day before lift-off. Barring surprises, the crew that will be launched into space should be the first of the two: Colonel Aleksander Volkov, Sergey Krikalev and Jean-Loup Chretien, the first French cosmonaut.

Sergey Krikalev is a Leningrader. He enrolled in the Leningrad Mechanical Institute after deciding that this institute would help him acquire a space profession.

He was not admitted to the aeroclub during his first year at the institute, since he was not 18 years old. He got in on his third try. He devoted practically all of his free time to airplanes and became a master of sport.

By reading newspapers, Krikalev figured out that the great majority of civilian cosmonauts were once employees of Korolev's design bureau.

In 1980, Krikalev found himself doing pre-diploma practice work in the "Korolev firm's" department of flight-document compilation. This required a good knowledge of training simulators and other equipment, so that instructions which cosmonauts follow in their work could be issued.

Krikalev applied almost immediately for enrollment in the cosmonaut contingent. He passed through the ordeal of selection successfully.

Work in which very complicated situations sometimes develop went on all the time. When the "Salyut-7" station went silent, for example, Krikalev was on a team which worked with a training simulator and prepared documents for V. Dzhanibekov and V. Savinykh, who had the task of reactivating "Salyut-7." This team's work was round-the-clock and difficult. Operations were rehearsed at an enterprise and at the Flight Control Center, so that the space crew would receive new recommendations in time.

In Moscow, during leaves of absence, Krikalev continued to fly and became a member of the Central Aeroclub. He still belongs to it and has achieved considerable successes. He became a champion of Moscow in 1983.

In November of 1985, Krikalev arrived at Star City for general space training. He was appointed to the first Soviet-French crew in March of 1988.

Chretien Contrasts Experience in Soviet Program With U.S. Shuttle Training

18660074g Moscow SOVETSKAYA ROSSIYA in Russian 27 Nov 88 p 1

[Article by A. Nemov, special correspondent at the Flight Control Center]

[Abstract] The article records conversations with Soviet and French cosmonauts who trained for the most recent mission on board the orbiting complex "Mir," other specialists, and members of the cosmonauts' families. The conversations took place a few days before the launch of the manned spaceship "Soyuz TM-7."

French cosmonaut Jean-Loup Chretien, who has trained for flights on both Soviet spacecraft and the U.S.' "Space Shuttle," is quoted in regard to advantages of cooperating with the USSR and work which the Soviet-French space crew was to perform during its stay on "Mir." He mentioned that the "Mir"—"Kvant" complex affords opportunities for conducting unique space experiments of prolonged duration. Chretien also praised Soviet work on maintaining the working fitness of cosmonauts on prolonged space missions and experience with preparing work in open space. He noted that the program for the upcoming mission includes studies of effects which space factors produce on various materials. Specimens of paints, reflecting coatings, composite materials, polymer films, and glass plates are to be placed on the outer surface of the orbiting station where they will be exposed to the action of particles and radiation for several months. The cosmonauts will also set up a special structure from an extendable girder in open space. This structure can serve as a platform for antennas and large structures. The condition of the human cardiovascular system in space flight, particularly the rate and character of circulation through blood vessels, is to be studied in an experiment called "Ekhografiya" (echography), using a video tape recorder and other modern methods.

Pilot-cosmonaut of the USSR P.R. Popovich, deputy head of the Cosmonaut Training Center, pointed out that after the visiting crew arrived, six cosmonauts would be on board "Mir" at one time, which would necessitate some readjustments. Some of the cosmonauts' research equipment, for example, would have to be placed in the complex's "sports" compartment, where the running track and stationary bicycle are located.

Volkov Comments on Upcoming Operations on 'Mir' Complex

18660074h Moscow SOVETSKAYA ROSSIYA in Russian 26 Nov 88 p 1

[Article by N. Zheleznov, special correspondent at the Baykonur Cosmodrome]

[Extract] Science commentators of [foreign] wire services, television companies and aerospace magazines who had arrived at the cosmodrome for the launch of the Soviet-French manned expedition met with members of the state commission which is coordinating all work in line with this program.

K. Kerimov, chairman of the commission, reported that the final pre-launch operations were proceeding precisely according to schedule. The rocket had passed vertical tests without criticism.

USSR first deputy health minister G. Sergeyev, who is taking part in work of the state commission, announced that the next primary crew of the "Mir" station would spend half a year in orbit.

Shortly after the primary and back-up crews [had been named], the members of the crews met with journalists.

Journalists asked the commander and flight engineer about their program of work on board the station following the completion of the Soviet-French expedition. "In addition to continuing the complete series of studies, we

shall conduct experiments with equipment delivered for the Soviet-French mission," said A. Volkov. "Also in prospect is extremely interesting work on adding a module for further equipping to the orbiting complex and putting this module into operation, as well as two egresses into open space. From a 'Progress' spaceship, we shall receive a self-contained system for moving about in open space. It appears, however, that it will be two Aleksandrs—Viktorenko and Serebrov—who will have to work in these unique space suits."

Launch of 'Soyuz TM-7'

18660074i Moscow PRAVDA in Russian 27 Nov 88 p 1

[TASS Report]

[Text] The spaceship "Soyuz TM-7" was launched from the Soviet Union on 26 November 1988, at 1850 hours Moscow time.

The spaceship is manned by an international crew: pilot-cosmonaut of the USSR Aleksandr Volkov, Hero of the Soviet Union and the commander; Sergey Krikalev, the flight engineer; and cosmonaut-researcher Jean-Loup Chretien, Hero of the Soviet Union and a citizen of the French Republic.

The program of the mission calls for the "Soyuz TM-7" ship to dock with the orbiting complex "Mir" and for scientific-technical research and experiments to be conducted jointly with cosmonauts Vladimir Titov, Musa Manarov and Valeriy Polyakov on board the complex.

The second Soviet-French space mission is being made in line with an agreement between the governments of the Union of Soviet Socialist Republics and the French Republic.

According to telemetry data and the crew's reports, the onboard systems of the spaceship "Soyuz TM-7" are functioning normally.

Cosmonauts Volkov, Krikalev and Chretien are feeling well.

(A photograph of A. Volkov, S. Krikalev and J.-L. Chretien is given.)

'Soyuz TM-7' Docks With 'Mir' Station Complex

18660074j Moscow PRAVDA in Russian 29 Nov 88 p 1

[Text] The spaceship "Soyuz TM-7" docked with the orbiting complex "Mir" on 28 November 1988, at 2016 hours Moscow time.

An international Soviet-French crew consisting of Vladimir Titov, Musa Manarov, Valeriy Polyakov, Aleksandr Volkov, Sergey Krikalev and Jean-Loup Chretien has begun conducting joint research in near-Earth orbit. Soviet and French specialists prepared a 23-day program for the mission of the six cosmonauts on board the "Mir" complex. This program calls for an egress of Soviet and French cosmonauts into open space and performance of a large amount of medical research and technical experiments.

On 21 December, Vladimir Titov, Musa Manarov and Jean-Loup Chretien will return to Earth in the spaceship "Soyuz TM-6." Aleksandr Volkov, Sergey Krikalev and Valeriy Polyakov will continue work on board the permanent manned complex.

The cosmonauts are feeling well.

The onboard systems and scientific apparatus of the orbiting complex "Mir" are functioning normally.

Special Foods, Psychological Support Measures for Crew

18660074k Moscow PRAVDA in Russian 29 Nov 88 p 3

[Article by A. Tarasov, special correspondent at the Flight Control center]

[Abstract] The article reports on measures which were being taken to maintain the morale and working fitness of the primary crew of the orbiting complex "Mir"—cosmonauts Vladimir Titov and Musa Manarov, who were nearing the end of a mission lasting almost a year—and also of the visiting Soviet-French crew. It is mentioned that the primary crew's working day has been shortened by two hours, and that medical specialists have instructed Titov and Manarov carefully to follow the pre-landing regimen of conditioning exercises prescribed for them.

It is recalled that foods specially prepared by French firms were carried on board the spaceship "Soyuz TM-7." About 50 different dishes were selected in France on a competitive basis and then underwent 6 months of tests in special chambers. These food rations also had to pass taste tests by cosmonauts before being approved for the mission. Among the items delivered to "Mir" were video cassettes prepared by a psychological support group, and an electronic instrument which is 70 centimeters long, 30 centimeters wide and 3 centimeters thick. This device can imitate the sound of a piano, harpsichord, organ or accordion.

'Soyuz' Spacecraft's Protection Against Accidental Collisions

18660074l Moscow TRUD in Russian 29 Nov 88 p 4

[Article by V. Golovachev, special correspondent at the Flight Control Center]

[Excerpt] The "Soyuz TM-7" spaceship's execution of maneuvers for rendezvousing with the "Mir" station must be controlled, as well as the precision of engine

firing and the length of time that the ship's engine is in operation. All of these data from Earth are fed into the ship's onboard computer via a command radio link.

I asked a specialist of the Flight Control Center whether the danger of a collision between a "Soyuz" spaceship and various objects in space increases during these maneuvers and shifting of the ship from one orbit to another. More than 5,000 useless structures (last stages of launch-rockets, casings, adapters, etc.) are now flying in near-Earth orbits, as well as more than 1,700 'payloads'-satellites, space stations, and probes intended for all kinds of purposes. Lastly, there are tens of thousands (as many as a million, according to some estimates) of small fragments of objects which have blown up in space.

"The likelihood that a spaceship will collide with such space 'junk' is small," replied the specialist.

"Designers have made provision even for this unlikely occurrence. If the ship's sealing is punctured, a pressurization system is switched on which gives the cosmonauts time to put on their space suits and take their places in seats. I would nevertheless like to hope that this emergency system will not be needed.

FTD/SNAP

Research Program of Soviet-French Mission

Crew Begins Research Program

18660075a Moscow PRAVDA in Russian 30 Nov 88 p 8

[TASS Report]

[Text] Flight Control Center, 29 November. The workday of the Soviet-French crew on board the orbiting complex "Mir" will last from 1100 to 2300 hours Moscow time. A substantial place is reserved for medical-biological experiments in today's plan of joint work.

Aleksandr Volkov, Sergey Krikalev and Jean-Loup Chretien have begun a series of studies whose task is to obtain data on the state of the human organism at the stage of adaptation to weightlessness and in the course of subsequent space flight.

The French cosmonaut is being examined with the aid of the "Ekhograf" apparatus. Indicators which characterize cardiac function are determined and blood flow in vessels of internal organs is studied by an ultrasonic method in the process of this examination.

The cosmonauts will perform an experiment called "Viminal," using a model of control of an aircraft. The purpose of this experiment is to evaluate the nature of operator activity and study features of interaction of the human visual and muscular systems in zero gravity.

Cosmic ionizing radiation in compartments of the orbiting complex will also be measured in the course of the day, using apparatus called "Tsirtseya."

Seven periods of research of the supernova in the Large Magellanic Cloud are planned today within the framework of the "Rentgen" program of astrophysical experiments.

Vladimir Titov, Musa Manarov and Valeriy Polyakov are helping the newly arrived crew in research that is being conducted, and they are passing on experience in work with equipment and apparatus of the manned complex "Mir."

According to reports from orbit and telemetry data, the flight is proceeding normally.

The cosmonauts are feeling well.

Adaptation, Physiological Studies

18660075b Moscow PRAVDA in Russian 1 Dec 88 p 1

[TASS Report]

[Text] Flight Control Center, 30 November. Cosmonauts Titov, Manarov, Polyakov, Volkov, Krikalev and Chretien are continuing joint work on board the orbiting complex "Mir." The latest series of medical-biological studies is on the program today.

For the purpose of obtaining information on features of cosmonauts' adaptation to zero gravity, the crew is conducting an experiment called "Minilab" which was prepared jointly by specialists of the Soviet Union, France and Czechoslovakia. The purpose of this experiment is to study hormonal regulation of metabolic processes in the human organism.

An echographic examination which the French cosmonaut is undergoing is being performed today with the aid of the pneumatic vacuum suit "Chibis," which simulates terrestrial gravity.

An experiment called "Fizali" is being conducted for the purpose of further studying the role of human sense organs in controlling the operation of the muscular system in zero gravity. Equipment which ensures simultaneous recording of numerous physiological signals, particularly of the bioelectric activity of muscles and movements of eyes and parts of the body, is used in this experiment.

Experiments for studying the effect of space-flight factors on development of higher plants and various biological specimens have begun on board the complex.

According to results of medical monitoring, all of the cosmonauts are healthy and feeling well.

The work in orbit is proceeding in accordance with the designated schedule.

Crew Prepares for EVA, Continues Biological Studies

18660075c Moscow PRAVDA in Russian 2 Dec 88 p 1

[TASS Report]

[Text] Flight Control Center, 1 December. The international Soviet-French crew is continuing joint research on board the orbiting complex "Mir."

In line with the mission program, an egress into open space by Aleksandr Volkov and Jean-Loup Chretien is planned for 9 December. The crew began preparing for this work today. They have to check gear and equipment needed for the egress and precisely determine the procedure for operations on the outer surface of the orbiting complex.

In line with the plan of medical examinations, the latest series of experiments for evaluating the condition of the cosmonauts' cardiovascular systems will be conducted in the course of the day, as well as a number of biochemical studies.

Experiments are continuing with biological specimens which were delivered to the orbiting station in the spaceship "Soyuz TM-7." The purpose of these experiments is to study features of calcium metabolism in higher plants at the initial stage of development and to evaluate dynamics of the growth of tissue cultures in conditions of space flight, in particular.

According to the crew's reports and telemetry data, the flight of the manned complex "Mir" is proceeding normally.

Cosmonauts Titov, Manarov, Polyakov, Volkov, Krikalev and Chretien are feeling well.

Adaptation Studies, Astrophysical Observations

18660075d Moscow PRAVDA in Russian 3 Dec 88 p 3

[TASS Report]

[Text] Flight Control Center, 2 December. The Soviet-French crew is conducting the latest series of "Ekhografiya," "Fizali" and "Viminal" experiments today, in line with the medical research program.

The purposes of these experiments are to evaluate comprehensively the state of the human organism in conditions of space flight and obtain data on the working fitness and psychophysiological reactions of cosmonauts at the stage of adaptation to zero gravity. An examination of the cardiovascular system during performance of physical exercises on the stationary bicycle is stipulated also for Aleksandr Volkov and Jean-Loup Chretien, who are to make an egress into open space.

In line with the plan of preparations for returning to Earth, Vladimir Titov and Musa Manarov, long-time occupants of the space station, are conducting conditioning exercises employing the pneumatic vacuum suit "Chibis."

Astrophysical experiments are continuing in line with the international program "Rentgen." Four more periods of observations of the supernova in the Large Magellanic Cloud are planned today.

Studies which have been conducted lately indicate that hard x-radiation of the supernova has decreased perceptibly as compared with data from observations made in January of this year. The weakening of the radiation flow is connected with decay of radioactive cobalt.

In the course of observations of an x-ray pulsar in the constellation Vela, the spectrum of this neutron star's radiation has been studied and a change in its period of rotation has been determined.

Data which have been obtained are being processed at the USSR Academy of Sciences' Institute of Space Research and also at institutes of countries which are taking part in the international project "Rentgen."

The flight of the manned complex "Mir" is proceeding normally.

Practical Applications of Physiological Research on 'Mir'

18660075e Moscow PRAVDA in Russian 3 Dec 88 p 3

[Article by A. Pokrovskiy]

[Excerpt] The Soviet-French space crew began its work with medical-biological experiments, including experiments with the "Ekhograf," an instrument which was developed in France in accordance with the latest achievements of medical technology.

"The 'Ekhograf' has demonstrated that we can build instruments as well and as cheaply as the Japanese," said Jean-Marie Pottier, an instructor of the university in Tours, France.

I had occasion to experience for myself how one of the instruments which were sent to the "Mir" station operates. The Soviet-French crew is to continue an experiment called "Poza" with the aid of this instrument. The problem is that commands for any of our movements are given by the brain, enlisting the services of various nervous structures from the spinal cord to the cortex of the large hemispheres and relying on 'readings' of our sense organs and various sensors located in muscles, joints, tendons and the skin.

The purpose of this research is not only to promote more efficient work by cosmonauts in orbit but also to aid development of the most highly perfected robots. A third

direction of experiments, "Fizali" ("Jellyfish"), is aimed at facilitating recognition of various disorders of the central nervous system which are accompanied by motor impairments. In any case, it quickly found a suitable sensor somewhere in my ankle. A very weak vibrator made me fall first forward and then backward, although physicians were supporting me by the shoulders.

An experiment called "Viminal" consists essentially in study of psychophysiological characteristics of human operator activity, using a model of aircraft control, and of changes in these characteristics during adaptation to zero gravity. This somewhat ponderous and academic terminology refers to an improvement with direct practical applications: a new and more comfortable lever for controlling airplanes has appeared.

Functions of French 'Ekhograf' Instrument

18660075f Moscow IZVESTIYA in Russian 2 Dec 88 p 4

[Article by B. Konovalov, special correspondent at the Flight Control Center

[Excerpt] Science on Earth has been studying how different people stand 'interplanetary disease.' This condition is now called by a more sophisticated name: the period of adaptation, or adjustment of an organism to conditions of zero gravity.

If danger signs appear during experiments in near-Earth orbit, this means that artificial gravity will have to be created on board spaceships bound for Mars.

The beginning of entry into zero-gravity conditions is now being studied in greater detail by French scientists. The main instrument that is being used in this research is called "Ekhograf." If was developed in Tours, in the local university's laboratory of biophysical medicine, which is headed by Professor Leandre Pourcelot.

The "Ekhograf," which was built by Matra, an eminent French firm, has a wide range of functions. In the first place, it makes it possible to evaluate the rate and nature of circulation through blood vessels and also to see images of the heart, arteries, veins, and blood vessels of internal organs on the screen of a video tape recorder which is built into the instrument. It is planned to conduct an examination of circulation through vessels of the brain, liver, kidneys and intestines in zero gravity for the first time during the [Soviet-French space] mission. Moreover, the "Ekhograf" makes it possible to study changes in the volume of the human shin which occur in conditions of zero gravity. The instrument measures arterial blood pressure and automatically records characteristics of the atmosphere inside the space station: pressure, temperature and humidity. All data are displayed on a screen in the course of an experiment and can be videotaped and transmitted to Earth at a convenient time.

Within the framework of an experiment called "Minilab," blood samples are taken directly on board the station in order to supplement data obtained with the "Ekhograf."

Commentary on Biomedical Research Program in Soviet-French Mission

18660075g Moscow MEDITSINSKAYA GAZETA in Russian 9 Dec 88 p 4

[Interview with G. V. Sergeyev conducted by V. Pishchik]

[Excerpt] MEDITSINSKAYA GAZETA's correspondent met with G.V. Sergeyev, USSR first deputy health minister and member of a state commission, and asked him to answer a number of questions.

"Gennadiy Vasilyevich, what medical-biological studies and experiments is the international crew conducting [on board the orbiting complex "Mir"], and what is their significance for space biology and medicine?"

"The experiment 'Ekhografiya' is aimed at studying the condition of the cardiovascular system extensively. The 'Ekhograf' apparatus makes it possible to look into the depths of the heart, so to speak, and evaluate changes in its pumping and contractile functions, as well as intracardiac hemodynamics. This experiment is conducted both in a state of rest and during exertion. Data which are obtained not only will expand our knowledge of the operation of the cardiovascular system in a space field but will aid development of new means of preventing adverse effects of weightlessness.

"An experiment called 'Minilab,' which was prepared by specialists of our country, France and Czechoslovakia, is important for understanding changes of metabolic processes in a cosmonaut's organism. Study of features of metabolism and its hormonal regulation during missions of different durations will make it possible to determine the nature of these features more fully and to develop still more effective means of prevention on this basis.

"Lastly, radiobiological studies are being conducted in the course of employing new approaches. Data on cosmic ionizing radiation in different flight paths will be obtained with the aid of French apparatus called 'Tsirtseya,' which will permit more accurate evaluation of effects which radiation produces on cosmonauts during a mission."

"What are the future prospects for this cooperation?"

"Participation of French specialists in development of equipment for biomedical research with a specialized medical-biological module could be quite helpful, it appears. Such a module would function as part of a manned orbiting complex."

Preparations for EVA by Cosmonauts Volkov and Chretien

18660075h Moscow PRAVDA in Russian 6 Dec 88 p 3

[TASS Report]

[Text] Flight Control Center, 5 December. The international Soviet-French crew is continuing to carry out the program of its joint mission.

The cosmonauts are now busy preparing for an egress of Aleksandr Volkov and Jean-Loup Chretien onto the outer surface of the orbiting complex "Mir" for the purpose of testing a large girder structure in conditions of open space.

The crew has reactivated space suits and checked the operational fitness of their life-support and temperature-control systems. The crew has readied equipment of the station's adapter module, which is used as a lock chamber in the process of egress into open space.

Today the cosmonauts are checking scientific apparatus which is needed for upcoming work.

On 4 December, an onboard press conference of the international crew was held for Soviet and foreign journalists who are covering this mission.

According to the cosmonauts' reports and telemetry data, the work in orbit is proceeding in line with the designated schedule.

Vladimir Titov, Musa Manarov, Valeriy Polyakov, Aleksandr Volkov, Sergey Krikalev and Jean-Loup Chretien are feeling well.

Cosmonauts Deploy Girder In 6-Hour EVA

18660075i Moscow PRAVDA in Russian 10 Dec 88 p 1

[TASS Report]

[Text] Flight Control Center, 9 December. Today Aleksandr Volkov and Jean-Loup Chretien made an egress into open space and performed scientific-technical experiments called for by the program of the Soviet-French mission.

At 1257 hours Moscow time, the cosmonauts opened a hatch of the station and carried out equipment and tools needed for their work. They installed a securing platform on a conical section of the station's adapter module and set up a girder structure, in a folded-up state, on a rod of this platform. On commands from a control desk in the station's working compartment and with the assistance of cosmonauts Volkov and Chretien, this structure was then unfolded and took the shape of a hexahedral prism with a maximum size of about 4 meters across.

In the course of this experiment, the process of unfolding the structure was recorded and dynamic characteristics of the structure determined with the aid of sensing and optoelectronic equipment.

The girder structure was separated from the securing platform after the planned work had been completed.

The cosmonauts installed a panel on the outer surface of the working compartment. On this panel are specimens intended for further study of effects which factors of open space produce on various structural materials, and also equipment for recording flows of micrometeorites.

The time that Aleksandr Volkov and Jean-Loup Chretien spent working in open space was six hours. The cosmonauts are healthy and feeling well.

Goals of 'ERA' Girder Deployment, Materials Exposure Study

18660075j Moscow PRAVDA in Russian 10 Dec 88 p 3

[Article by A. Pokrovskiy]

[Excerpt] Aleksandr Volkov and Jean-Loup Chretien began carrying out experiments called "Obraztsy" (specimens) and "Era" on the outside of the "Mir" station, while Vladimir Titov, Musa Manarov and Valeriy Polyakov followed their actions from inside the station. Sergey Krikalev was on duty at a control desk.

On the screen of a television set at the Flight Control Center, Chretien could be seen moving slowly along the surface of the station, carrying a panel with specimens of materials which a special commission had selected in the course of a broad scientific competition. For about half a year, these specimens will feel the effects of factors of open space. Soviet cosmonauts must then remove them, during the next egress, and deliver them to Earth for further study of their physical and chemical characteristics, so that they can be used in space and on Earth.

The next experiment, "Era," is also a step toward industrialization of space. From a bundle of tubes made of a carbon-filled plastic, Aleksandr Volkov and Jean-Loup Chretien assembled a structure which can serve in the future as a platform for various antennas or a large unit. From his control desk, Sergey Krikalev issued commands for opening up this structure.

Details of 'ERA' Girder Experiment

18660075k Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 10 Dec 88 p 4

[Article by G. Lomanov, special correspondent at the Flight Control Center]

[Excerpt] Soviet cosmonauts have gone out into open space more than 20 times, but these operations, as always, are difficult and dangerous and require careful preparation. Especially today's.

The cosmonauts had to unfold a complex three-dimensional structure weighing about 60 kilograms, and they had to set up a securing platform weighing close to 80 kilograms, which was built especially for this structure.

A cargo spaceship delivered to the station 230 kilograms of equipment intended for this experiment alone. This equipment had to be unpacked, set up and checked. What was the purpose of all this effort?

"To test a complex three-dimensional girder in real space conditions," said Candidate of Technical Sciences V. Ivanov. The name of this experiment, 'ERA,' is simply an acronym of the words 'component of a folding antenna.'

"When folded up, this structure resembles a bundle of brushwood, and when it is straightened out, the carbon-filled plastic tubes from which the 'ERA' is assembled outline the shape of a huge hexahedral 'screw nut' almost 4 meters in size."

"An electric motor with a cam is installed in one of the girder's joints," added Claude Ance, a representative of the firm which built the structure. "When the girder is unfolded, this motor begins to shake it a little; it is designed with 20 different running modes. Those which will not give rise to resonance in the station's components were selected for the experiment, of course. More than 20 accelerometers and dozens of temperature-sensitive elements are installed in different places on the girder. We will compare readings of these instruments with a mathematical model in order to see whether the actual behavior of this structure corresponds to our calculations. We hope to obtain good material for development of larger girders of this type."

Unique pictures were recorded on video tape. Engineers on Earth will subsequently play this tape dozens of times, carefully observing vibrations of the three-dimensional structure. Instruments installed on the control desk were, on the whole, somewhat reminiscent of a spider, which finds out, from the swaying of its web, what is going on in the network it has deployed. Equipment which French engineers developed thus creates a kind of 'drawing' of the girder on the basis of vibrations.

Problem With 'ERA' Girder Deployment Extends EVA

18660075l Moscow IZVESTIYA in Russian 11 Dec 88 p 3

[Article by B. Konovalov, special correspondent at the Flight Control Center]

[Excerpt] The egress into space began with preparation of space suits. These suits, which bear the proud name "Orlan" [sea eagle], are of the semirigid type.

Jean-Loup Chretien and Aleksandr Volkov put on the "Orlan" suits on 9 December. And Musa Manarov occupied his working station inside the reentry vehicle of the spaceship "Soyuz TM-6."

Sergey Krikalev took his place at the control desk of French equipment and prepared for video recording. Vladimir Titov took over general direction of communications with the crew and the Flight Control Center (TsUP), and Valeriy Polyakov monitored his comrades' medical characteristics continuously.

Chretien and Volkov were both working in open space for the first time and fell a little behind schedule at the start. Chretien removed the protective coverings from two containers of equipment for the "ERA" experiment.

A securing platform was first installed on handrails which run along the surface of the station. A rod set into this platform was subsequently raised at a 45-degree angle. The 'bundle' of a folding structure was then attached to this rod. On a command from Krikalev, an electric motor was supposed to 'shake' for 15 minutes the hexahedron that would open up, and transducers and television cameras would record this structure's behavior. After that, it would be expelled and depart into space. Such was the plan.

But the "ERA" did not wish to open up, despite all of the crew's efforts.

Communications with TsUP ceased. There was tumult in the center.

Everyone stopped talking when the orbiting complex entered the zone of radio contact with the ship "Akademik Sergey Korolev" and Volkov's voice was transmitted to us: "It opened!"

"We have carried out the entire program and expelled the antenna," said Chretien. "We have fastened specimens [to the outer surface of the station]."

Now they would have to get inside the station quickly. The cosmonauts had been working for about 6 hours instead of the planned 4 hours and 20 minutes. Their space suits had reached the limit of their service life. Volkov and Chretien had already been in open space for a record period of time.

Experiment Director Explains Problem in 'ERA' Deployment

18660075m Moscow SOVETSKAYA ROSSIYA in Russian 10 Dec 88 pp 1-2

[Article by Aleksandr Nemov, correspondent]

[Abstract] The article gives an account of operations which members of the crew of the orbiting station "Mir" performed recently in line with the experiments "Era" and "Obraztsy." The oxygen supply of the space suits

which the cosmonauts wore during these operations is sufficient for about six hours in open space and eight hours in all, the author relates. While cosmonauts Jean-Loup Chretien and Aleksandr Volkov worked on the outer surface of the station, Musa Manarov was stationed inside the spaceship "Soyuz TM-6," so that he, Volkov and Chretien could make an emergency descent to Earth if an accident occurred.

Patrick Aubry, director of the "Era" experiment, explained that the unfolding girder structure which the cosmonauts had to install outside the station was kept from opening up by plastic restraining threads. After they were cut, the structure would unfold into a hexahedron almost 4 meters in size, through the action of springs. Because of delays, this operation did not begin until the station was outside the zone of radio communication with the Flight Control Center, it is recalled. During the next period of communication, Volkov reported that the restraining threads on the girder had been cut according to plan, but the structure had not unfolded. An engine which produces vibration disturbances on the girder was then switched on by Sergey Krikalev from his control desk, but the structure still failed to open up. Before the cosmonauts left the zone of radio visibility again, they were advised to try manipulating the structure carefully with the aid of a long screwdriver, or to use a hammer if this failed.

Between periods of communication, Yu. P. Semenov, chief designer of manned spaceships and stations, flight director V.V. Ryumin, V.A. Shatalov, head of the Cosmonaut Training Center, and dozens of other specialists conferred upon measures to be taken if the girder could not be made to open up during the time allotted for the work in open space. If the structure were left folded up, it might spring open unpredictably and damage a solar battery, it was pointed out. The structure could be expelled from the station into space by means of spring pushers provided for this purpose, without completing the experiment. This was considered the preferable alternative. Such a step never became necessary, however; the structure finally unfolded when Volkov gave it a nudge with his foot. The girder was expelled into space after the cosmonauts completed vibration studies called for by the "Era" experiment. The cosmonauts' egress ended two hours behind schedule.

The purpose of the "Era" experiment is to study how the girder reacts to artificial disturbances, according to Aubry. V. Ivanov, who is in charge of this experiment on the Soviet side, related that the girder was built by France's "Aerospatiale" firm, one of the developers of the supersonic airplane "Concorde." The girder's behavior while being acted upon by disturbances was recorded by 21 vibration transducers and 10 temperature-sensitive elements. The behavior of any segment of the girder can be ascertained by processing this information with computers. Results of the experiment will further development of larger structures which will be installed on spacecraft in the future, and of sensitive systems for monitoring the condition of these structures. "Aerospatiale" plans to develop an antenna for space satellites on the basis of a girder of the type used in the "Era" studies, for example.

S. Naumov, who is in charge of the "Obraztsy" experiment on the Soviet side, mentioned that selection of materials capable of withstanding conditions of space flight is one of the problems on which developers of France's reusable spaceship "Hermes" are working. The "Obraztsy" experiment calls for composite materials, polymer films, various kinds of glass, and heat-shielding coatings to be placed on the outside of the station. Also installed there are special traps for micrometeorites which allow the date of each micrometeorite impact to be recorded in a computer's memory.

Structural Details of 'ERA,' Future Applications

18660075n Moscow TRUD in Russian 10 Dec 88 p 1

[Article by V. Golovachev, special correspondent at Flight Control Center]

[Excerpt] The work outside the orbiting complex lasted for six hours.

The "Era" experiment was a highlight of this program.

The plan of this experiment was as follows. On the outer surface of the station, the cosmonauts would install a securing platform with a heavy rod which could be raised and take an inclined position. Volkov and Chretien would fasten a folded-up structure to the raised rod and remove a protective covering from this structure. A video unit would be installed not far from the platform.

The command for the opening-up of the structure would come from inside the station, from S. Krikalev's control board. But A. Volkov and J.-L. Chretien would have to go to a safer place in connection with this. The commander would head for the station's 'underside' (its body would protect him) over a radial route, clinging to handles, while the cosmonaut-researcher would move along the surface of "Mir" and take cover behind a solar battery.

Krikalev pressed a button on the control desk, and a 'heat knife' (a coil which heats up) cut a strong, fine plastic thread which was restraining the structure. Springs in the structure's hinges were supposed to straighten out, so that the heap of tubes, which resembled a bundle of brushwood, would rise up, straighten out and turn into the skeleton of a hexahedron with the correct shape. The almost 300 pipes of the structure were to form 24 cells. An identical hexahedron was installed in the main control room. The maximum size of this structure is 3.8 meters, and it is a meter 'thick.' Each of its rigid tubes, which are made of a carbon-filled plastic, has a wall only 0.04 millimeter thick—essentially a thin film. The unfolding structure's hinge joints are made of a lightweight metal alloy, and the mass of the whole

structure is about 60 kilograms. Joel Toulouse, director of the "Aragats" project, informed journalists that the French side financed preparation and developments of the "Era" experiment and building of the structure and other equipment for it.

The "Era" experiment is very important for the purpose of designing strong space platforms, antennas and telescopes of the future. These platforms can be either independent—i.e., they can 'float' about the station—or joined to the station by a connecting cable (in the manner of a trailer on a rope). The large mirror of an extraterrestrial telescope also can be conveniently assembled from such cells. They have still another purpose: base blocks with different shapes are obtained from these modules, which can be easily rearranged.

'Viminal' Visual-Motor Adaptation Experiment

18660075o Moscow IZVESTIYA in Russian 9 Dec 88 p 2

[Article by B. Konovalov, special correspondent at Flight Control Center]

[Abstract] The article discusses the methods and purposes of an experiment called "Viminal" which French cosmonaut Jean-Loup Chretien was conducting on board the orbiting complex "Mir." The word "Viminal," it is explained, is an abbreviation of this experiment's French title, which is translated as "visual-motor adaptation during prolonged flight."

The equipment of the "Viminal" experiment is said to include a video screen in the "Ekhograf" unit and a control lever which is equipped with transducers for monitoring actions of the cosmonaut who is operating it. This lever is connected to an equipment-complex which records the time it takes the cosmonaut to react to images and registers whether he reacted properly or not. The lever operates in two modes. In one, it moves in proportion to the muscular effort of the cosmonaut's grip on the lever; in the other, it moves freely, as if uncoupled. The cosmonaut's actions are displayed on the screen in such a way that "the image follows the grip" as it would be if an airplane or a spacecraft were being controlled.

In one experiment, two tetrahedrons appear on the screen. Using the grips, the cosmonaut has to join them optimally from the standpoint of time or distance. In another experiment, a moving cross appears on the screen and the cosmonaut must "drive" it to the center of the picture. The movement of the cross is constantly accelerating.

In a study of visual perception, images of two three-dimensional figures with complex geometrical shapes must appear on the screen in different orientations. The figures can be absolutely identical but in different positions, or the second figure can be a mirror-image of the first. The cosmonaut must determine whether they are identical or whether the second is a mirror-image of the first.

In another experiment, Chretien must develop different muscular efforts on the lever from memory in order to carry out the assignment.

It is noted in conclusion that these electronic "games" are not for the amusement of the cosmonaut. It is necessary for specialists to study the effect of weightlessness on muscular training, examining interaction of the visual and motor systems in the process of operator activity of cosmonauts.

'Physalie' Sensory-Motor Adaptation Experiment

18660075p Moscow IZVESTIYA in Russian 13 Dec 88 p 2

[Article by B. Konovalov, special correspondent at the Flight Control Center]

[Extract] "Fizali" [French: "Physalie"] is an abbreviation of the French name of an experiment, "sensory-motor adaptation to prolonged flight and effects of weightlessness." At the same time, this abbreviation means "jellyfish" in French. This coincidence pleases specialists, because in zero gravity a cosmonaut floats about freely, like a jellyfish in water.

The 'sensors' of such a jellyfish-like person begin to send different signals. How and by what mechanism does a cosmonaut cope with this? The "Fizali" experiment's authors—scientists of the laboratory of neurosensory physiology of France's National Center for Scientific Research—are interested in these questions.

This research is a continuation of an experiment called "Poza" (posture) which Jean-Loup Chretien conducted on board "Salyut-7" during his first mission in 1982.

In Paris, Claudie Andre-Dee, a physician and cosmonaut candidate, acquainted us with the "Fizali" experiment.

"In character, it is a basic-research experiment," she told us. "Its main purpose is to understand mechanics of interaction between the sensory and motor systems. Movement of the eyes is recorded with the aid of small electrodes fastened to a cosmonaut's head. The cosmonaut puts on a mask with a funnel-shaped opening made of rubber. This mask has a screen on which small red and black squares appear. The character of their horizontal and vertical movement changes. This affects posture. Sometimes the cosmonaut wants to take a step forward. While he is doing this, eye movement is recorded in an electronic memory. Movement of the torso will be recorded with the aid of television cameras. In another

experiment, a target is set up. A point moves along cross-shaped and sinusoidal paths on this target. This point can be followed by turning the head and moving the eyes."

Claudie suggested that I guess the number which an instrument about the size of an electric shaver seemingly was tracing on my hand with small needles. It has been found that a person's skin sensations change in space. Precisely how they change is determined with the aid of a dactyl matrix.

"Will medical practice on Earth benefit from the 'Fizali' experiment?," I asked.

"Certainly," replied Andre-Dee. "I spend half of my working time in a clinic, dealing with patients. Adaptation to movement following prolonged bed rest is a problem for many of them. Moreover, study of the movement control mechanism can facilitate recognition of different disorders by the central nervous system."

'Amadeus' Experiment Studies Solar Battery Structure

18660075q Moscow PRAVDA in Russian 13 Dec 88 p 1

[TASS Report]

[Text] Flight Control Center, 12 December. The international crew consisting of Vladimir Titov, Musa Manarov, Valeriy Polyakov, Aleksandr Volkov, Sergey Krikalev and Jean-Loup Chretien is continuing joint research and experiments in near-Earth orbit.

During the past two days, the cosmonauts performed final operations following work connected with the egress into open space, and they cleaned rooms of the orbiting complex. Jean-Loup Chretien underwent the latest echographic examination in line with the program of medical research.

Several more periods of observation of the supernova in the Large Magellanic Cloud were conducted on 11 December with the aid of the "Rentgen" observatory.

Today the Soviet-French crew is performing a series of experiments called "Amadeus," the purpose of which is to study processes of the opening-up of a mock-up of a load-bearing structure of a solar battery in conditions of zero gravity and to evaluate the quality of hinge joints of a new type with reduced friction. Kinematics of the opening of the structure are recorded on video tape, using two television cameras with infrared illumination.

According to telemetry information and reports from orbit, the flight of the manned complex "Mir" is proceeding normally.

The cosmonauts are healthy and feeling well.

Details of 'Amadeus,' 'Erkos' Experiments

18660075r Moscow IZVESTIYA in Russian 14 Dec 88 p 2

[Article by B. Konovalov, special correspondent at the Flight Control Center]

[Excerpt] The program of the Soviet-French space mission is attracting specialists' attention by virtue of its well-thought-out nature and logic and the diversity of its tasks, which have both immediate and long-range prospects.

The technological experiment "Amadeus," like the ERA experiment, is being conducted jointly by France's National Center for Space Research and well-known "Aerospatiale" firm. Utilization of a new type of hinge is the main objective of this experiment. This hinge will be employed for opening up solar batteries and other components extending from spacecraft. The hinge joint, which is called "Carpentier," is a kind of bearing without ball elements. Its reduced frictional force makes it attractive to specialists.

The cosmonauts are opening up the "Amadeus" system inside the station. The task here is not simply to check the system's operational fitness but to record all details of this process. Infrared lighting, corner reflectors and two video cameras are used for this purpose. These cameras are the same ones that were employed in the medical-biological experiment "Fizali." The authors of the "Amadeus" experiment are interested in the qualitative aspects but mainly in the quantitative aspects of the new hinge joint's operation in zero gravity. Data obtained must become the basis of a mathematical model of the opening-up of various structures. The French specialists' approach is well characterized as a search for the new and a mathematical transition from the specific to the general. The experiment is basic in character and at the same time of tremendous practical significance.

An experiment called "Erkos" is being conducted on board "Mir" in precisely the same manner, with a dual purpose. One problem which French specialists have encountered is that heavy ions of solar, galactic and extragalactic origin which penetrate into near-Earth space produce harmful effects on electronic units, particularly large integrated microcircuits. Failures of electronic systems have occurred on many satellites because of this. The purpose of the "Erkos" experiment is to determine the content of heavy ions in near-Earth space in order to verify mathematical reference models, and also to evaluate the operational fitness of various electronic-memory microcircuits without which development of modern instruments is inconceivable.

Crew Continues Medical, Ionizing Radiation Studies

18660075s Moscow IZVESTIYA in Russian 16 Dec 88 p 1

[TASS Report]

[Text] Flight Control Center, 15 December. Vladimir Titov, Musa Manarov, Valeriy Polyakov, Aleksandr Volkov, Sergey Krikalev and Jean-Loup Chretien are continuing their joint work on board the orbiting complex "Mir."

During the first period of communications in the morning, the cosmonauts gave a television report on the progress of the "Minilab" experiment. In the course of this experiment, physician Valeriy Polyakov took a sample of venous blood from Jean-Loup Chretien for subsequent laboratory analysis on Earth. In combination with echograpic examinations, results of these studies will make it possible to obtain more complete information on the functional state of the human organism at different stages of space flight.

The latest series of measurements of cosmic ionizing radiation along the flight path of the orbiting complex will be conducted with the aid of the "Tsirtseya" apparatus in the course of the day.

According to the crew's reports and telemetry data, the work in orbit is proceeding in line with the designated program. The cosmonauts are working harmoniously, and their morale is good.

Biomedical, Botanical Studies Continue

18660075t Moscow PRAVDA in Russian 17 Dec 88 p 1

[TASS Report]

[Text] Flight Control Center, 16 December. The latest work week is ending on board the scientific research complex "Mir."

Today the international Soviet-French crew will be engaged chiefly in medical research. Under the observation of Valeriy Polyakov, Aleksandr Volkov and Jean-Loup Chretien will perform several more series of experiments aimed at obtaining additional information on features of human adaptation in zero gravity. The day's program also includes measurements of cosmic ionizing radiation along the flight path of the orbiting complex.

Experiments for further studying the development of higher plants and other biological specimens in conditions of orbital flight are continuing in the space hothouses "Vazon" and "Svetoblok."

In the course of the day, Vladimir Titov and Musa Manarov will continue to familiarize Aleksandr Volkov and Sergey Krikalev with features of the operation of onboard systems and research equipment of the station. In particular, the cosmonauts will work today with the astronomical complex "Rozhen," which was built by Bulgarian specialists.

During periods of communications, the crew has reported that the flight is proceeding in accordance with the designated schedule. The condition of the Soviet and French cosmonauts' health is good, and they are feeling well.

Physical Exams, Gas Composition Studies

18660075u Moscow PRAVDA in Russian 18 Dec 88 p 2

[TASS Report]

[Text] Flight Control Center, 17 December. The Soviet-French crew consisting of Vladimir Titov, Musa Manarov, Valeriy Polyakov, Aleksandr Volkov, Sergey Krikalev and Jean-Loup Chretien is continuing its work on board the orbiting complex "Mir."

In line with the program of the joint mission, one more series of medical studies prepared by Soviet and French specialists is being conducted today. Aleksandr Volkov will undergo an echographic examination, and Jean-Loup Chretien will perform "Fizali" and "Viminal" experiments. The purpose of these studies is to evaluate comprehensively the state of the human organism in conditions of space flight and to obtain additional information on psychophysiological reactions of cosmonauts at the stage of adaptation to weightlessness.

The long-time occupants of the orbiting complex, Vladimir Titov and Musa Manarov, will perform a number of experiments for the purpose of studying dynamics of the gas medium in the station's compartments and changes in its composition, and they will conduct two-hour exercises with a physical-culture conditioning set.

The day's agenda reserves time also for a television report in which the cosmonauts will tell about their work in orbit.

The flight of the manned complex "Mir" is proceeding normally. FTD/SNAP

The Orbital Space Observatory 'Gamma'

18660015 Moscow ZEMLYA I VSELENNAYA in Russian No 5, Sep-Oct 88 pp 5-13

[Article by Doctor of Physical and Mathematical Sciences V. G. Kirillov-Ugryumov, Moscow Engineering and Physics Institute, and USSR Academy of Sciences Corresponding Member Yu. P. Semenov, USSR Glavkosmos; first paragraph appears in boldface in source]

[Text] **The launch of the space observatory Gamma into near-Earth orbit is approaching. Although the energy of gamma quanta is great, their flux near Earth is negligible. Gamma astronomy outside the atmosphere has the potential for looking even farther than radioastronomy and "seeing" still earlier epochs of development of the Universe.**

Cosmic Gamma Quanta

The unique Gamma-1 telescope is designed to record electromagnetic cosmic radiation with energies of between 50 MeV and 5 GeV. What can research in this range of cosmic radiation yield? The lower boundary of the range is close to the energy of gamma quanta in the decay of neutral pions at rest (67.5 MeV). Along with other particles, neutral pions come about in the interaction of atomic nuclei, when the energy of incident particles exceeds hundreds of MeV per nucleon. When the energy of bombarding nucleons increases, the energy of secondary gamma quanta from the decay of pions also grows. The Gamma-1 telescope, therefore, will make it possible not only to detect interactions of nuclei in space accompanied by a considerable release of energy, but also to measure the energy spectrum of the "original parents" of the gamma quanta. Fast protons and the nuclei of helium and other elements make up nearly 99 percent of the composition of cosmic rays, and their energies can reach levels many orders of magnitude greater than the energies of particles in ground-based accelerators. The energies borne by cosmic rays and relative to a unit of volume of interstellar space are comparable to the specific energies of the magnetic galactic field, the relict electromagnetic radiation, and the turbulent motion of interstellar gas. This points to the role of cosmic rays in the life of the galaxy. That is why the problem of the origin of cosmic rays remains one of the key problems of astrophysics.

By measuring the flux of gamma radiation from the decay of neutral pions and using data on the density of interstellar gas from optical astronomy and radioastronomy, one can determine the intensity of cosmic rays in various regions of our galaxy and obtain, finally, an answer to the question, "Where were the cosmic rays born—in our galaxy or outside it?" There are reasons for using observational gamma astronomy to "see" the hot points themselves where cosmic rays are born. The path of charged particles from the spot of generation to the observer is entangled in interstellar magnetic fields, and cosmic rays therefore fall on the Earth isotropically and uniformly on all sides. Gamma quanta themselves move in a straight line and can point to the cradle of the cosmic rays.

Neutral pions are also born in the annihilation of atomic nuclei. In the annihilation of an antiproton and a proton, as many as 14 pions are generated simultaneously. Recording bursts of gamma radiation in the region of energies of hundreds of MeV can indicate the point of contact of antimatter and matter if it exists.

The decay of neutral pions is not the only process that generates energetic gamma quanta. Their birthplaces can be extremely large, essentially inaccessible from Earth, gravity or electromagnetic fields that exist in the environs of such astrophysical objects as neutron stars, quasars, or black holes. The density of matter of neutron stars reaches 100 million tons/cm^3, whereas the flux density of the magnetic fields reaches 10^{12} gauss. In such magnetic fields, gamma radiation can, for example, be a result of radiation that "bends" when electrons move along magnetic force lines—a process that cannot be duplicated in laboratories on Earth. The special interest that studies of energetic electromagnetic radiation from space hold stems from the fact that the processes of particle interaction here are sometimes described at the margins of the physical laws known to us. It is precisely here that the junction between the physics of the macro world and the micro world is glimpsed.

Yet another attractive facet of studies of cosmic gamma radiation is its immense penetrating ability. Radiation in the range detected by the Gamma-1 telescope can originate from objects located beyond the range of optical telescopes and even radiotelescopes. If the red shift of the energy spectrum lines of astrophysical objects is used to characterize distance, then the most remote and, consequently, the youngest objects in terms of the evolutionary process of the Universe in the gamma range must have a red shift an order of magnitude greater than radio sources.

At the same time, gamma quanta, traversing a distance of billions of light years in space with virtually no interaction with matter, cannot penetrate the Earth's atmospheric layer. After all, even in the galaxy, in interstellar space, the density of gas is just one atom per cubic centimeter, whereas in intergalactic space, it is several orders of magnitude less. The absorption of primary gamma quanta in the atmosphere forces us to study them in a range of energies of up to several GeV at the edge of the atmosphere or to study them beyond reaches of the atmosphere.

The Existing Observational Data

What exactly is known today about cosmic gamma radiation with energies of about a hundred MeV? Virtually the entire mass of observational data in that energy

range was gathered in 1975-1982 by the special European gamma satellite COS-B. On a gamma-ray map of the sky charted on the basis COS-B data, a narrow, bright band running along the plane of the galaxy is the first thing that captures one's attention. There is no doubt that one of the sources of gamma quanta here consists of the diffuse emissions that result from the interaction of cosmic rays and interstellar gas and dust. However, since the angular resolution of the COS-B gamma telescope for quanta with energies of 100 MeV was 4.5°, one cannot discount the substantial contribution made to the emissions coming from the plane of the galaxy by local gamma point sources that the telescope could not resolve. For that reason, the structure of the diffuse gamma emissions of the galaxy constitutes one of the questions that must be resolved in the research to come.

The local gamma sources and gamma stars are the most intriguing phenomena on the map of the sky. Twenty-four of them have been recorded in the second catalog of such sources that was compiled from COS-B data. However, we can definitely say something of the nature of only two of the sources, which coincide positionally with the pulsars Vela and Crab. The pulsar Vela, by the way, is the brightest source in the gamma sky. The flux of gamma radiation from it in the energy range we studied is 13 X 10^{-6} quanta per second per square centimeter.

Rigidly periodic pulses are a peculiar feature of pulsar emissions. The Vela pulsar has a pulse period of 89 msec, and the Crab pulsar, 33 msec. That exact kind of periodicity was observed, respectively, in two gamma sources, which removed the doubt about whether it is these pulsars that serve as gamma-emission sources. But attempts with the COS-B telescope to detect gamma emissions from other pulsars were unsuccessful. And the need to search out new gamma pulsars for a consistent explanation of the mechanism of their gamma emissions is undisputed.

Light curves of both these sources have an important similarity: two pulses separated by the same phase interval (i.e., the same fraction of pulsation period) of 0.42 are visible in the gamma range. But there are many differences: in the Crab pulsar, a light curve similar in shape is observed both in the radio and optical ranges and in the x-ray range. The Vela pulsar has only one pulse in the radio range and two phase-shifted pulses in the optical range, and no pulses have been detected in the x-ray range. Between 1975 and 1980, the intensity of the emissions of the Vela pulsar changed three times. By the way, the electromagnetic emission maximum of Vela corresponds to an energy of nearly 1 GeV, which is many orders of magnitude greater than the energies of the radio, optical, and x-ray ranges. Of course, the difference between the Crab and Vela pulsars has to do with their ages: one is nearly a thousand years old, the other is about 6,000 years old. But for creating a complete theory of gamma pulsars, two objects are not enough, and additional studies of the characteristics of those same Crab and Vela pulsars are also needed.

As for the nature of the other sources listed in the COS-B catalog, either there are shared assumptions—for example, that half of the sources are very dense gas-and-dust clouds illuminated by cosmic rays (this hypothesis, however, must be substantiated by studies of greater accuracy)—or there is heated debate about the nature of individual sources that stems from the inconsistency of the observational data on these objects.

Since this debate illustrates the level of current observational data in gamma astronomy and, correspondingly, affects the choice of parameters of observational instruments and the program of scientific observations that lie ahead, let us briefly pause on matters related to the binary x-ray source Cygnus X-3. There was a powerful radioburst from this source in September 1972—its emissions grew 1,000-fold. The Moscow Engineering and Physics Institute's gamma telescope, at the edge of the atmosphere, and the ground-based superhigh-energy cosmic gamma radiation Cerenkov counter of KrAO [not further identified] of the USSR Academy of Sciences detected Cyg X-3 pulsations with a period of 4.8 hours for gamma quanta energies near 100 MeV and greater than 10^{11} eV. The shape of the light curve in both pieces of equipment was a narrow burst of gamma emissions at a phase of 0.2. Later, with the American SAS-2 gamma satellite, the experiment's authors also reported periodic gamma emissions from Cyg X-3 with an energy of nearly 100 MeV. They indicated the position of the gamma burst on the light curve to be in the phase region of 0.6.

Many installations have been used in the 1980s to perform a series of observations of Cyg X-3 in the region of superhigh energies, and gamma radiation pulses have been detected right up to gamma quanta energies of 10^{16} eV. Gamma bursts have been observed at a phase of 0.2 as well as 0.6.

After bringing the observational data together, specialists from the Whipple Laboratory (USA) concluded that Cyg X-3 is not merely one of the most powerful gamma sources in the galaxy (its luminosity is about 10^{38}ergs/sec), but, more than anything else, an efficient source of cosmic rays. Such a fundamental conclusion, however, leaves open the question of the results of the COS-B observation of the region of the sky in which Cyg X-3 is located, since COS-B recorded two strong gamma sources here, but did not detect any variability in their emissions. How can this be explained? Was it due to experiment errors, or to the physics of these processes, in which the generation of gamma quanta depends on the activity of the source, on a different mechanism of emission depending on its energy, or on the location of the source in relation to the Earth? There are reports of the existence of several other periods at Cyg X-3—34.1 days, 328 days, and 12.6 msec—in addition to the period of 4.8 hours.

At any rate, the low intensities of the primary gamma radiation and the immense background created by charged particles whose flux is 10^4 times greater than the

fluxes we studied compel us to cast a critical eye on the capabilities of the first cosmic gamma detectors. After all, before the launch of the specialized SAS-2 and COS-B gamma satellites, dozens of gamma sources had been "discovered," but virtually all the data on them turned out to be unsound when they were thoroughly examined. There are no grounds for absolutizing a single conclusion reached by COS-B.

The COS-B catalog contains the source 2GC 291+65, which has been identified with quasar 3C 272. It is not out of the question that this source is wholly or partially due to emissions from the Mg50 galaxy, which is 1.6SD from 3C 273. Thus, the question remains, Did COS-B detect the gamma radiation of a quasar?

Doubts about the reliability of time-related changes detected by COS-B have to do with the periodicity of emissions of the second-brightest source in the gamma sky, which has been given the name Heming. This source was first detected by the SAS-2 satellite, which reported pulsations with a period of 59 seconds. However, COS-B, having confirmed the presence of a gamma source, "closed off" its variability. But when the American x-ray satellite Einstein, which is equipped with sensitive gear, made observations of the region of the sky in which Heming is located, it put the period of the source at the same 59 seconds.

Then, in 1986, pulsing radiation was detected from the region of the 2GC 006-00 gamma source with an energy of nearly 10^{12} eV and a period of 112.54 msec. That is the period of the PSR 1802-23 pulsar, whose properties are similar to those of the Crab pulsar. The 2GC 006-00 source is rather bright (7th among those in the COS-B catalog), and no one can say exactly why COS-B did not notice its pulsing.

Let us turn our attention to another conclusion drawn from the existing observational data—the variability, the sporadic appearance and disappearance of the source. The gamma source 2GC 356-00, for example, was detected by COS-B in an observational session with a reliability that virtually excluded any doubt about its existence. But in three subsequent sessions, it could not be found. Such appearing and disappearing needs to be observed simultaneously in different ranges of the electromagnetic spectrum. For that reason, on their large space observatories, the USSR and the United States are planning not only to use instruments with substantially better characteristics, but also to install on the observatories a complex of detectors that measure in different energy ranges. In our country, it was academicians V. L. Ginzburg and R. Z. Sagdeyev who proved the importance and the urgency of observing cosmic gamma radiation and of taking the initiative to create orbital gamma space observatories.

The Instrumentation of the Gamma Observatory

The orbital space observatory Gamma is a spacecraft that weighs a total of about two tons and flies in near-Earth orbit at an altitude of about 400 km. Its service life is about two years. The craft is equipped with instrumentation that, upon command from Earth, can change the observatory's attitude and maintain within 30 minutes of arc the direction of the axes of the telescopes relative to the stars when measurements lasting weeks are being made. Solar batteries supply the power for the scientific gear, the telemetry, and the craft's equipment. Three telescopes will be installed on the craft—the Gamma-1, the Disk, and the Pulsar X-2. The **Gamma-1** telescope is located inside the spacecraft, in conditions whose temperature and pressure guarantee the normal operation of spark chambers bonded with glass plates. A necessary condition for the stable operation of a spark chamber is the periodic replacement of the gas that fills the chamber, because of its gradual pollution. A special device on board effects a metered scavenging of the chambers and releases the spent gas into space in such a manner that it does not affect the observatory's orientation in space. The Telezvezda star sensor makes it possible to determine the attitude of Gamma-1's axis at the moment of measurement within 5 minutes of arc.

The Disk and Pulsar X-2 telescopes are mounted outside the observatory. They are accompanied by devices that make corrections in the mutual positioning of the axes of the telescopes if there is any deformation of the fuselage of the craft after the craft is placed into orbit.

The scientific data undergo some preliminary processing with on-board computers and are then "cast" down to Earth with telemetry. As much as 60 megabytes of data can be thus processed in a 24-hour period.

The Basic Mission of the Observatory

Based on the characteristics of the measurement instruments aboard the orbital space observatory Gamma, the principal tasks that can be performed by the observatory may include following:

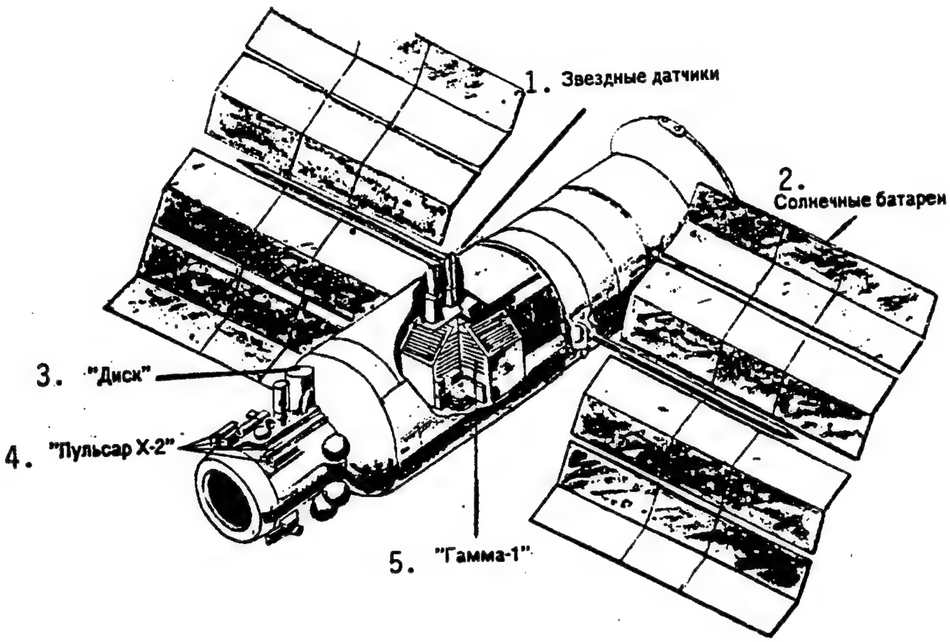
—a varied and fuller study of the properties of known local galactic sources of gamma radiation and a search for new ones (the number of gamma sources may grow substantially)

—study of diffuse galactic gamma radiation in order to determine its nature and the intensity distribution of cosmic rays in various sectors of interstellar space

—clarification of the mechanism of radiation of nuclei of active galaxies, including quasars

—determination of the structure and energy spectrum of isotropic extragalactic gamma radiation.

As for a specific timetable of observations of astrophysical objects, it can be compiled only when the precise date for the launch of the observatory into orbit is known. It can happen that the conditions for observing a given target in a given period of time are unfavorable,

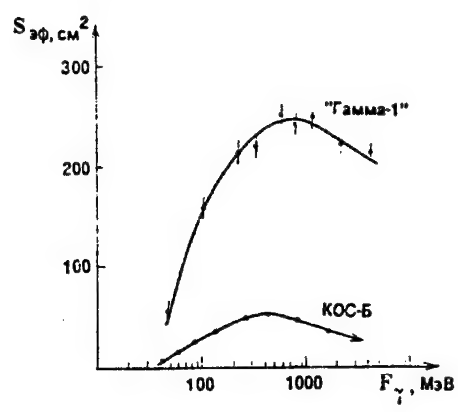


Mockup of the Gamma orbital space observatory

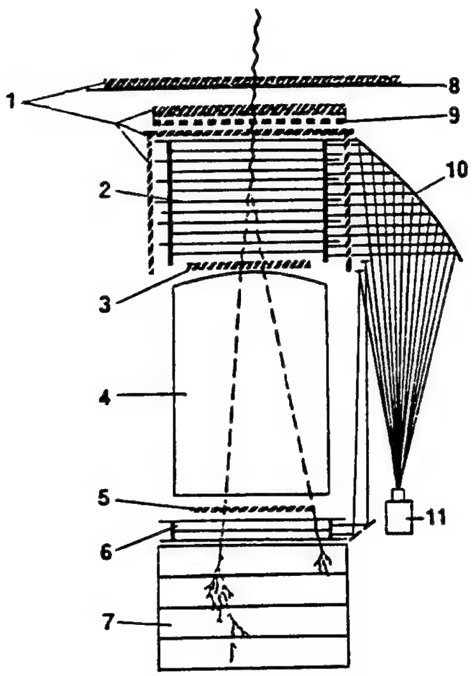
Key: 1.star sensors—2.solar batteries—3. "Disk"—4. "Pulsar X-1"—5."Gamma-1"

because, for example, the direct rays of the sun enter the star sensor or the Earth eclipses the source. However, we can still name several targets that will probably be included in the observational mission. First of all, observations of at least one well-known gamma point source—Vela or Crab—are needed to calibrate the instruments. Repeated observations are also advisable of the objects that we spoke of earlier and where experimental data evoke differing explanations.

In connection with that, we should note that the angle of viewing of the Gamma-1 telescope is about 20°, which means that, when the axis of the telescope is aimed at one object, other sources can also be "seen" that are located in that same, relatively large area of sky. The Large Magellanic Cloud, which has a supernova, will undoubtedly be scheduled for observation (ZEMLYA I VSELENNAYA, 1987, No 3, p 111—*Ed.*). It is not out of the question that the high-energy gamma emissions of a supernova remnant that may not be observable today—because of absorption in the expanding, massive shell of the exploding star—may be accessible to observation by the time the observatory is placed in operation. Nor can we today discount the presence of a neutron star in the center of a supernova remnant, and its detection would have tremendous importance for the theory of evolution of stars. When **Gamma** is making its measurements in space, the need is obvious for an early match-up and day-to-day communications with ground-based observatories that can make synchronous observations of the very same astrophysical objects in the radio, infrared, and optical ranges, as well as in the range of superhigh-energy gamma quanta (which is especially important for the scientific mission of the Gamma observatory). And it is possible that an "unexpected" powerful burst from some object could be detected in the radio or optical ranges or in the range of superhigh-energies of electromagnetic cosmic radiation, and then the telescopes on the orbital observatories would take aim at the new astrophysical object. Just what can these new telescopes do?



Effective sensitive area for a paraxial source



Schematic of the Gamma-1 telescope

Key: 1—Anticoincidence scintillation counters; 2—12-gap spark chamber; 3—upper scintillation counter; 4—Cerenkov gas counter; 5—lower scintillation counter; 6—two-gap spark chamber; 7—scintillation calorimeter; 8—hull of satellite; 9—screen; 10—mirror system; 11—television camera

Gamma-1

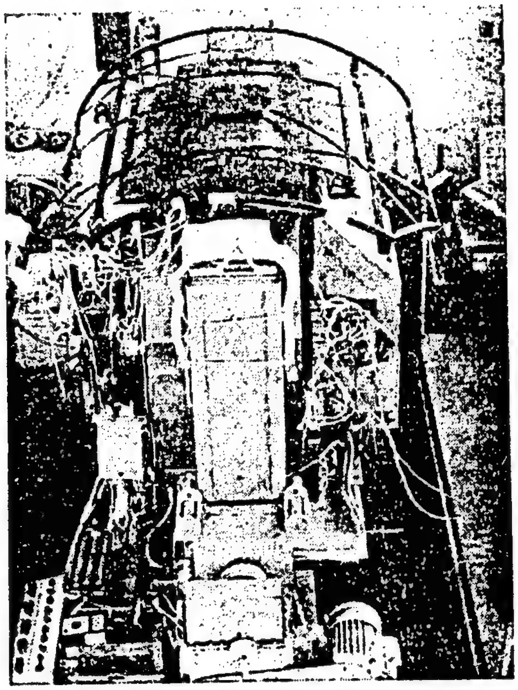
The Gamma-1 telescope was developed by the USSR Academy of Sciences Space Research Institute (the head institute), the Academy's Physics Institute imeni P. N. Lebedev, the Academy's Physical and Technical Institute imeni A. F. Ioffe, the Moscow Engineering and Physics Institute, and Soviet industrial enterprises, as well as by the French Center for Nuclear Research in Saclay and the Center for Cosmic Radiation Research in Toulouse. The star sensor Telezvezda for the Gamma-1 telescope was developed by scientists of the Polish Academy of Sciences. The heart of the telescope is the spark chamber, in whose plates cosmic gamma quanta form electron-positron particle pairs. Along the tracks of the charged particles there occurs a spark-over, which enables the detection of these particles and, with the help of a television camera, the measurement of their coordinates and the direction of motion of the primary gamma quantum. High voltage is fed to the chamber's plates by a control pulse, which is formed by electronic devices when two scintillation counters are triggered beneath the spark chamber and above the ionization calorimeter. The ionization calorimeter consists of flat scintillation counters interlayered with lead sheets—for measuring the energy of the recorded gamma quanta. Great care was taken with the Gamma-1 telescope to suppress backgrounds, which mimic the recording of primary gamma quanta. In addition to scintillation counters that are hooked up for anticoincidence, there is a gas counter.

The Cerenkov gas counter, filled with freon, has two important features. First, it feeds a signal to the electronic device only when an electron or a positron with an energy of no more than 7 MeV, or a heavy particle with an energy greater than 12 GeV/nucleon, has passed through it. The signal can be incorporated in the program for forming the control pulse and thereby suppress the background of low-energy charged particles. Second, the counter is sensitive to the direction of motion of particles and makes it possible to reduce by 100-fold the flux of charged particles that are moving in the unit from the calorimeter and that can produce in the spark chamber's plates a picture that looks like the recording of gamma quanta.

This flux is further reduced—tenfold—by the transit-time system. The distance between the scintillation counters above and below the Cerenkov counter is 75 cm. Relativistic particles traverse this distance in about 2 nsec. That is enough time for the electronic logic to determine the direction of motion of the particles. Playing a decisive role in separating the cosmic gamma quanta from other particles that evoke the formation of a control pulse is the entire picture of the arrangement of the particle tracks in the main 12-gap spark chamber and in the spark chamber right above the ionization calorimeter. All these measures should raise the reliability of the experimental data obtained by Gamma-1 well above the COS-B data.

The most important feature characterizing the telescope's sensitivity for recording discrete sources is angular resolution. Gamma-1's angular resolution is better than that of COS-B by a factor of 2.5.

Calibration measurements of the Gamma-1 telescope were performed with a beam of tracer gamma quanta on the synchrotron of the Physics Institute imeni Lebedev, Pakhra. The results of these measurements indicated that the effective sensitive area for a paraxial source[1] and the angular resolution of the Gamma-1 telescope are substantially greater than that of the COS-B telescope. Observing a local source with a galactic bacground for 2.5×10^6 sec, Gamma-1 can detect an object generating a flux of gamma emissions with energies greater than 100 meV, the magnitude of which is about 2×10^{-7} quanta per cm^{-2} sec^{-1}, with a reliability of 5 standard errors. The minimum intensity of local sources included in the COS-B catalog, however, is 10^{-6} quanta per cm^{-2} sec^{-1}. The data obtained in the calibration of the Gamma-1 telescope agree with calculations made with the Monte Carlo method. Of course, an image of an actual gamma point source that lives up to the potential of this telescope will be obtained when, flying in space, it observes



Calibration of the Gamma-1 telescope with an accelerator

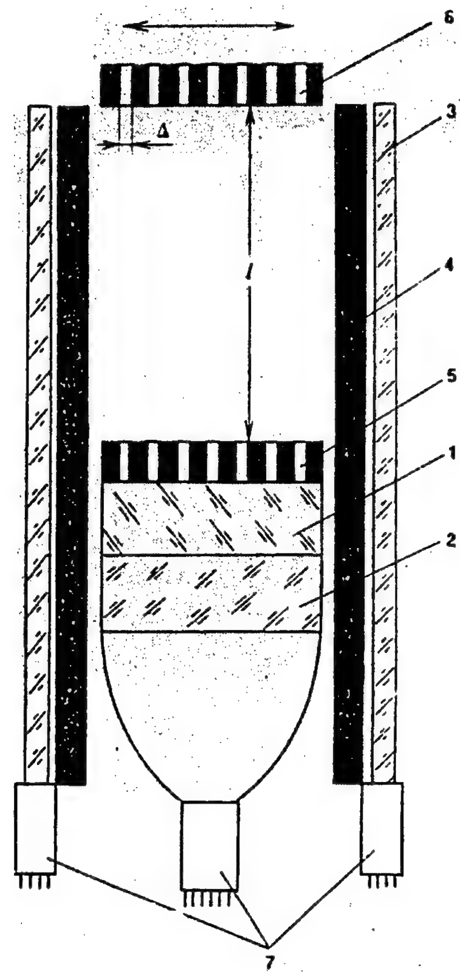
a strong gamma point source, such as the Vela pulsar. Since the angular resolution depends on the energy of the gamma quanta, the function of the "response" of an actual point source will depend on the source's energy spectrum. It is our hope that the high sensitivity of the Gamma-1 telescope will make it possible to "see" entire constellations of yet-to-be-discovered gamma sources.

Disk

The Disk telescope was designed to record electromagnetic radiation in the range of 0.1-8 MeV. It was developed by the USSR Academy of Sciences Physical and Technical Institute imeni A. F. Ioffe.

The Disk records gamma quanta by modulating the flux of gamma radiation from the source with a mesh screen and recording the radiation synchronously by positioning the screen's axis relative to the telescope.

The axis of the Disk telescope is set up parallel to the axis of the Gamma-1 telescope. Measurement of the energy of the gamma quanta takes place in an NaJ(Tl) full absorption crystal sunk into a well of lead and active collimator, that is, by scintillation counters switched to an anticoincidence mode when the pulse is recorded in the NaJ(Tl) crystal. A CsJ(Tl) crystal also makes up one of the components of the counters switched to anticoincidence. It is scanned by the same photomultiplier that



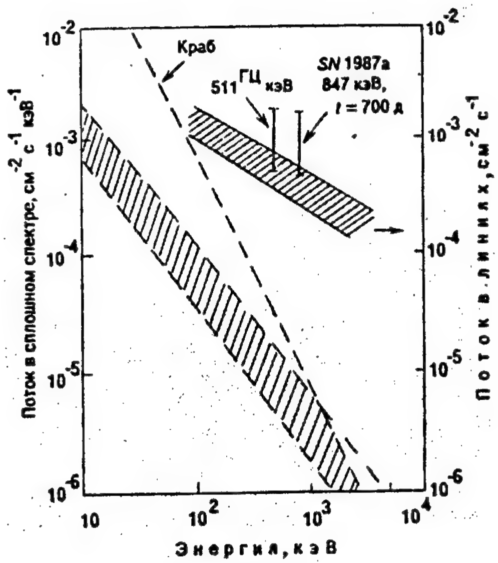
Schematic of the Disk gamma telescope

Key: 1—NaJ(Tl) crystal; 2—CsJ(Tl) crystal; 3—protective plastic scintillator; 4—lead collimator; 5—immoveable screen; 6—modulating screen; 7—photomultipliers

scans the primary NaJ(Tl) crystal. The signals from the different crystals are multiplexed by an electronic device according to pulse shape. The Disk can determine the coordinates of a source within 20-30 minutes of arc, and its accuracy is comparable to the angular resolution of the main telescope, Gamma-1. Tests of the Disk telescope aboard the Meteor satellite with a static screen were able to locate a source such as Crab within several minutes.

Pulsar X-2

This x-ray telescope is the third telescope aboard the orbital space observatory. Its range of energies is from 3 keV to 25 keV. It was designed by staff members of the



The minimum flux of gamma radiation as recorded by the Disk telescope (calculated by the Physical and Technical Institute imeni A. F. Ioffe of the USSR Academy of Sciences). The dotted line designates the energy spectrum of Crab, whereas the vertical segments indicate the line 0.511 MeV from the center of the galaxy and the expected radiation in the line 0.847 MeV from supernova 1987A some 700 days after the burst(exposure time, 10^5 sec)

USSR Academy of Sciences Space Research Institute. A component part of the telescope is the Spektr-2 microcomputer, which is on board the observatory itself. It was designed by French specialists.

The Pulsar X-2 consists of four independent proportional counters. Of fundamental importance is the arrangement of the counters. The axes of the counters are separated from each other by 10°, which makes it possible to determine, from the counting rate in each detector, the direction to a target within 30 minutes of arc. The central axis of symmetry of the entire system of counters is parallel to the axes of the Gamma-1 and Disk telescopes, so that selected astrophysical objects can be observed simultaneously.

An important trait of the Pulsar X-2 is its ability to measure periods of variable sources that range from 8 msec to several days. The telescope is capable of detecting a periodic source such as Crab, but with a brightness that is a hundred times fainter. It is significant that the Pulsar X-2 will make it possible to record time-related changes not only of the flux of x-ray photons, but also of their energy spectrum—specifically, of the brightness of the iron atom line at 6.7 keV, for, after all, the remnants of supernova explosions should be rich with such atoms.

Six years have passed since the completion of the COS-B gamma satellite's mission. These have been years of "stagnation" in observational gamma astronomy in the energy range that is in the hundreds of MeV. That is why astrophysics is impatiently awaiting the results of the measurements made with the Soviet and American gamma observatories (launch is slated for 1990), that is, measurements with a new generation of telescopes that should make a substantial contribution to our knowledge of the world around us.

'Glazar' Orbital Telescope

18660195 Moscow ZEMLYA I VSELENNAYA in Russian No 3, May-Jun 88 pp 11-14

[Article by G. M. Tovmasyan, Doctor of Mathematical and Physical Sciences, Byurakan Astrophysical Observatory, Armenian SSR Academy of Sciences; article titled "In Orbit—the Glazar"; first paragraph, which appears in italics in source, is introduction to article]

[Text] For more than a year, the Glazar telescope—designed for charting the sky in the far ultraviolet range and, specifically, for finding undiscovered galaxies and quasars that emit a considerable amount of their energy in the ultraviolet range—has been operating in orbit as part of the Kvant astrophysical platform. Its name comes from the words "galaktika" [galaxy] and "kvazar" [quasar].

"Yuriy Viktorovich! Be aware, please, that on the next revolution, when you move into the shadow of the Earth, the length of the session for the region of the sky that we are observing now will increase. You will be able to give greater exposures."

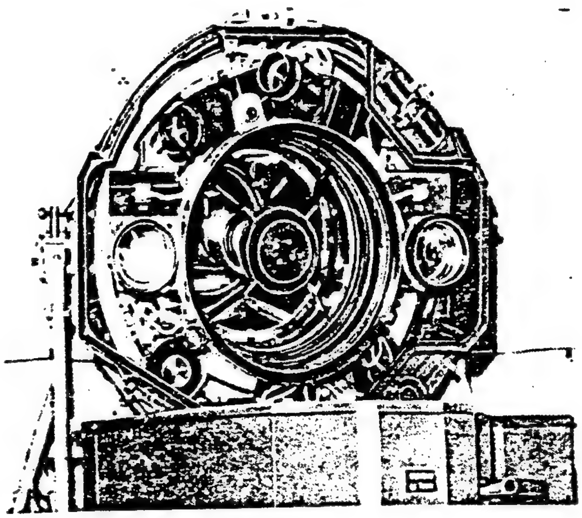
"Yes, we already noted that in the radio message. Everything will be done as it should be."

"Another thing. Pay attention to how the "Zakhvat" (capture) signal behaves. Sometimes it can pulse a little."

"We'll keep an eye on it constantly, and we won't forget, of course, about the "Razgerm" (depressurization) indicator..."

That is how the Flight Control Center discussed the details of the observations the "Taymyrs" were about to make with the Glazar ultraviolet telescope during a communications session.

Glazar was place into orbit on 30 March 1987, as part of the Kvant platform (Zemlya i Vselennaya, 1987, No 4, second cover page—*Ed.*). After a week of trouble and an unscheduled EVA by cosmonauts Yu. Romanenko and A. Laveykin, the Kvant platform docked with the Mir



The Glazar telescope

station. A so-called routine docking was hindered by some foreign object (something similar to a burlap bag)—heaven knows where it came from and how it got into the docking assembly.

Two more EVAs were required to prepare the Glazar, as well as a set of x-ray telescopes also aboard Kvant, for operation. It was necessary to install new solar batteries for starting the gyrodynes. It was only because of them that it was possible to stabilize the station in a certain direction for a long enough period of time and with a high degree of accuracy—up to one angular minute—without disturbing the operation of Kvant's scientific gear and with the most efficiency. After all, if the rocket engines had been used to keep the station properly oriented in a given direction, the stabilization itself, for one thing, would have been rough, and the exhaust plumes, for another, would have disturbed the ultraviolet and x-ray observations considerably.

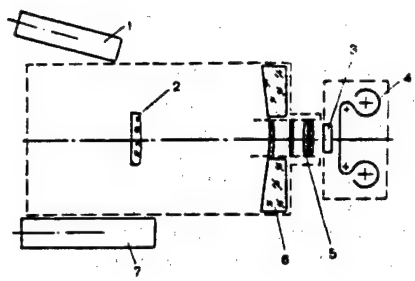
After the additional solar batteries were installed and the gyrodynes started, various assemblies of the Glazar were tested, in June and July 1987. The tests showed all the assemblies to be functioning normally, without exception. This was confirmed when the Soviet-Syrian crew delivered the film exposed during the tests back to Earth.

What kinds of tasks has Glazar been called upon to perform in orbit? Its main task is to compile a map of the sky in the far UV range that cannot be seen from Earth.

Since the earliest of times, man studied the world around him by observing the light given off by it and, in the case of the objects of the solar system, the light reflected by them. But light is only a small part of the broad spectrum of electromagnetic radiation; it passes through the Earth's atmosphere unimpeded, and the human eye is sensitive to it. Thus, the surface temperature of the coldest stars visible to the human eye is around 3000 K, whereas the surface temperature of the hottest stars is several tens of thousands of degrees Kelvin. Radio astronomy observation methods opened an entirely new world of celestial objects—a world of radio galaxies and quasars, which have powerful radio emissions. The mechanism of radio emissions turned out to be non-thermal, one described by Planck's Law, to which the stars conform when they emit radiation. The spectrum of this radiation was similar to the radiation spectrum of electrons moving at relativistic velocities in a magnetic field. Researchers encountered this radiation for the first time ever when they accelerated particles in a synchrotron, and for that reason they called the radiation they discovered near celestial objects **synchrotron radiation.** The discovery of radio galaxies led to Academician V. A. Ambartsumyan's discovery of activity at the centers of the galaxies. This activity is accompanied by not only powerful radio emissions, but also by colossal explosions and ejections of huge masses of matter. The radiation emanating from the active centers of galaxies and quasars—objects that are in a transitional phase of their development—is extremely important for understanding their nature and the formation and evolution of stellar systems, which, in turn, brings us closer to an understanding of the processes attending the formation of individual stars.

Still another manifestation of activity at the center of galaxies and quasars is the abundance of ultraviolet radiation in them. A survey of the sky performed at the Byurakan Astrophysical Observatory with the wide-field telescope of a Schmidt system combined with an objective prism has led to the discovery of more than 2,000 galaxies that have an abundance of ultraviolet radiation and are called Markaryan galaxies. The overwhelming majority of them are Seyfert galaxies with clearly active nuclei, in which the stormy processes of star formation take place. The processes that take place in Markaryan galaxies are so interesting that for many years now they have been the focus of attention of astronomers from around the world, who are studying them with every means possible.

Among the means used is the Glazar, a telescope that enables a survey of the sky in the far ultraviolet (in the region of 1600 angstroms), which cannot pass through the Earth's atmosphere. Such a survey could lead to the discovery of hitherto unknown galaxies and quasars that emit a considerable amount of their energy in the UV range. By the way, the telescope's name itself, Glazar, comes from the words "galaktika" and "kvazar." Galaxies and quasars that are already known will also be studied with the telescope. Measurement of the radiation intensity in the 1600-angstrom band will make it possible to study the energy distribution in their spectra up to the far ultraviolet. In addition, Glazar will enable the measurement of the ultraviolet emissions of stars. Of



Optical configuration of the Glazar telescope: 1—star sensor B; 2—secondary mirror; 3—microchannel amplifier; 4—photographic film; 5—corrector; 6—main mirror; 7—star sensor A

particular interest here are hot stars in **stellar associations.** Far-ultraviolet observations of stellar association regions makes it possible to make a detailed determination of dust distribution in them.

Obviously, to do survey work, a telescope must have the largest field of view possible. The Glazar, with Ritchey-Chretien optics, has a field of view (diameter, 1.3°) that meets that requirement. The diameter of the field of view in the focal plane is equal to 40 mm. At the focal point is a UV detector that uses a multichannel plate. Incoming radiation from celestial targets is magnified roughly a thousand times in the detector and is converted to the visible wavelength range, which is recorded on standard photographic film. The film is nearly 8 m long and is loaded in a special cassette. After the film is shot, the cosmonauts replace it with new film. The reloading takes place through an airlock. For this, the telescope is placed in its initial position, and the lock shutters that cover the telescope at its base, where the main mirror is located, are closed. After the pressure in the lock is brought up to normal, a cosmonaut opens the cover and changes the cassette in the photochamber. After the cosmonaut checks to see that the lock cover is closed properly, the shutters are opened, and the Glazar is again ready to operate.

To make observations according to coordinates assigned from Earth, before entering the Earth's shadow, the entire Mir station turns toward the sector of the sky being photographed, and gyrodynes maintain that orientation to an accuracy of up to one angular minute. After the ship has entered the shadow, the telescope's **star sensor** is switched on. The diameter of the field of view of the sensor is equal to 1°. If the star that is guiding the telescope comes into the field of view of the sensor, then the sensor, as if were, "captures" the star and, despite small oscillations of the entire station, maintains the aim of the telescope with a very high accuracy—up to 2-3 angular seconds. If the "guide" star does not come into the sensor's field of view immediately, a search program is initiated, and the entire telescope begins to move in a spiral trajectory—up to 3° from the direction taken by the station, until the guide star is captured by the sensor. The star sensor uses two coordinates in a plane perpendicular to the telescope's axis to maintain the telescope's orientation. However, the telescope can, with the entire station, rotate around its own optical axis, which leads to photo "smearing." To prevent this smearing, the telescope is equipped with a **second star sensor,** which is pointed in a direction that forms an angle of about 45° with the axis of the telescope. Its capture of the appropriate star brings any rotation of the telescope around its own axis to a halt.

Both star sensors (sensor A, which uses two coordinates to stabilize the telescope, and sensor B, which prevents rotation of the telescope around its own axis) use fairly bright stars (up to 3.5 stellar magnitude in photographic beams). There are not all that many such stars in the sky—two-three hundred in all. It would seem that Glazar is capable of studying only a very small part of the sky. Its potential, however, has been expanded considerably. The fact is that in the initial position, the axis of star sensor A is skewed from the axis of the telescope by 0.75°, and not only is the region of the sky around the guide star photographed, but also the adjacent region. In addition, the telescope has a **second star sensor A.** (Such redundancy usually exists to improve the operational reliability of gear in orbit.) In the Glazar, the axis of the second star sensor is skewed in the other direction from the telescope's axis, which makes it possible to photograph a second region of the sky symmetrically located in relation to the guide star.

Besides that, each of the A sensors can also be repositioned in relation to the telescope (in two steps of 0.9° each, in a direction perpendicular to a line that joins them). They move in opposite directions. This makes it possible to photograph six sectors of the sky with one guide star. The arrangement of the six sectors depends on the attitude of the telescope with the entire station in space, that is, on the direction to the star from star sensor B. A given shift of the two B sensors relatively to each other (40° in a plane perpendicular to the axis of the telescope) enables 12 different regions of the sky to be photographed with one guide star. When several stars are used for the B sensors, an area of sky around the A sensor star of nearly 25 square degrees can be photographed.

The telescope can operate in **three modes.** In **automatic** mode, commands for Glazar are issued by telemetry channel. The second mode is **semiautomatic:** the cosmonauts issue all the necessary orders to the telescope with a console inside the station. The telescope then takes several shots automatically, changing the position of one of the A sensors. In **manual** mode, the telescope is completely controlled by the cosmonauts. This mode was used in the initial stages of operation of Glazar, when the possible divergence between the axis of the space station and that of the telescope itself was not

known. It is also used to observe targets of interest for which there are no appropriate guide stars. That is how the supernova in the Large Magellanic Cloud was studied (Zemlya i Vselennaya, 1987, No 6, p 54—*Ed.*). In the manual mode, the photography is performed by stabilizing the station itself, without switching on the telescopes star sensors. Since stabilization of the station is worse than of the telescope—on the order of one angular minute—the images of the stars are blurred. This leads to a worsening of resolution and, as a result of that, to a diminution of the threshold stellar magnitude by $4\text{-}5^m$. If stars with magnitudes of up to 13^m can be photographed in the 1600-angstrom band with an eight-minute exposure when the telescope's stabilization system is operating, stars with magnitudes of only up to $11\text{-}12^m$ can be photographed when the system is not operating. In this mode, however, one can of course observe the very bright supernova in the Large Magellanic Cloud, as well as many active galaxies.

A great many observation sessions were done with Glazar between August and December 1987. Nearly 130 regions of the sky were photographed. A total of nearly 300 images were obtained. Observations of the supernova were included in the research mission, and the supernova—as well as several active galaxies—was photographed monthly. Basically, the observations were made in the regions of predetermined stars in order to chart the sky and to search for galaxies and quasars with an abundance of UV radiation.

Returning to Earth, Yu. Romanenko and A. Aleksandrov brought with them three cassettes of photographic film, which are already being analyzed by specialists.

UDC 629.78

Two-Stage Method for Determining Orbital Elements of Artificial Earth Satellites

18660234a Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 10 May 86) pp 353-357

[Article by Yu. S. Savrasov and V. N. Yerofeyev]

[Abstract] A two-stage method for determining preliminary orbits which is based primarily on the use of the most informative range measurements is described. Formulas are derived which first make it possible to estimate the parameters of the orbital plane and then to compute the remaining elements. Perturbation due to the Earth's asphericity and lunar and solar attraction is taken into account when determining the orbits. The proposed method is most effective when processing observations of artificial satellites in high orbits. It is shown that the two-stage method ensures a more precise preliminary orbit than does the two-positions method. For example, the gain in accuracy in determining perigee distance is by a factor of 3 for satellites with H = 500 km and increases by a factor up to 30 for satellites with H = 40 000 km. This is attributable to the fact that with an increase in altitude the linear errors in measuring satellite position increase, resulting in a worsening in the accuracy in determining orbits in the two-positions method. The errors in measuring range are not dependent on satellite flight altitude. The accuracy characteristics of the two-stage method therefore virtually do not change with an increase in H. With respect to calculation time, the two-positions and the two-stage methods are approximately equivalent and are more economical by a factor of 10-20 than the least squares method. References: 4 Russian.

UDC 612.014

Semiempirical Method for Calculating Stationary Photoelectron Fluxes

18660234b Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 19 Aug 86) pp 406-412

[Article by V. A. Kiselev]

[Abstract] The basis for the described work was a study by V. A. Kiselev, et al. in GEOMAGNETIZM I AERONOMIYA, Vol 25, No 4, pp 677-679, 1985, which described the possibility of an invariant form of representation of the relative spectrum of photoelectrons. A method is now proposed for computing stationary fluxes of photoelectrons, including determination of the relative spectrum from the "reduced" spectrum of photoelectrons; for computing the absolute intensity of the flux for a fixed energy using an analytical formula derived by integration of the Boltzmann kinetic equation for energies; and for computing the fine structure of the spectrum of photoelectrons on the basis of a precise solution of the initial equation. The spectra of photoelectrons computed by the proposed method for the altitude range 150-350 km and the dependence of the fluxes at an energy 7-9 eV on solar zenith angle are compared with measurements made on the AE-E satellite; satisfactory agreement was found. This method makes it possible to compute the stationary fluxes of photoelectrons for different heliophysical conditions. Figures 4; references 13: 5 Russian, 8 Western.

UDC 551.521.8

Anisotropy of Electron Temperature Caused by Plasmaspheric Heating by Ion-Cyclotron Waves

18660234c Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 30 Oct 86) pp413-419

[Article by Yu. V. Konikov and G. V. Khazanov]

[Abstract] The heating of thermal electrons by electromagnetic ion-cyclotron waves generated during interaction between the plasmasphere and the ring current is examined in a quasilinear approximation. An estimate

of the anisotropy of electron temperature is given for the conditions of the outer plasmasphere. The anisotropy should increase with transition to nighttime conditions as a result of attenuation of the relaxation process due to a decrease in the plasma concentration. The efficiency of the different sources of anisotropization of the energy distribution of electrons is examined in detail. It is shown that the heat flow emanating from the plasmasphere causes a considerable anisotropy of electron temperature in the subauroral ionosphere. Figures 3; references 19: 7 Russian, 12 Western.

UDC 612.014

Stochastic Instability of Charged Particles in Geomagnetic Trap During Magnetic Storms
18660234d Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 19 Mar 88) pp 420-429

[Article by V. D. Ilin, I. V. Ilin and S. N. Kuznetsov]

[Abstract] Applying the ideas and concepts of the theory of dynamic stochasticity to the radiation belts during a magnetically quiet period, a study was made of the nonadiabatic effects of motion of trapped particles during magnetic field depression. It was assumed that the temporal change of the geomagnetic field occurs reversibly and adiabatically. Trapped protons with energies of about 1-100 MeV were examined as examples. The stochastic instability of charged particles in the Earth's magnetosphere in the presence of D_{st} variations was examined in detail. The basis for the research was the concept of nonlinear resonances between particle oscillations with different degrees of freedom. The mechanism of irreversible changes in the fluxes of high-energy trapped particles after magnetic disturbances is explained on this basis. The theoretical results are confirmed by experimental artificial Earth satellite data. It is shown that during a magnetic storm there is a marked intensification of processes of stochastization of motion of trapped particles, the instability region becomes larger, and an additional mechanism arises for the transfer of particles from the region of stable motion into an unstable state. Depending on the asymmetry of the ring current, a leakage of particles can be caused by modulation-type diffusion or global stochasticity. The stochastic losses mechanism makes possible a quantitative explanation of the observed nonadiabatic effects in the radiation belts during geomagnetic disturbances. Figures 3; references 18: 8 Russian, 10 Western.

UDC 550.383

Correlation Between Leakage of High-Energy Electrons, Longitudinal Electric Currents and Westerly Electrojet
18660234e Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 19 Jun 87) pp 457-462

[Article by A. V. Dronov and V. Ye. Tsirs]

[Abstract] On the basis of measurements on the Cosmos-426 satellite (1971) and the Cosmos-900 and Intercosmos-17 satellites (1977) a study was made of the correlation between the leakage of high-energy electrons and protons (greater than 30 keV) and longitudinal electric currents and the position of the westerly electrojet in the active phase of a substorm. The greatest fluxes of leaking high-energy electrons are in the region of the outflowing current; the greatest proton fluxes leak predominantly in the region of the inflowing current. In the active substorm phase the greatest fluxes of high-energy electrons are registered on the leading edge of the westerly electrojet. The strongest fluxes of high-energy electrons with an isotropic pitch angle distribution are registered in the WTS region by satellites in low orbits. There is a tendency to a linear dependence of the logarithm of electron intensity on the AL index for the region of the outflowing current in the evening and pre-midnight sector. These findings are useful for detecting longitudinal currents on the basis of the distribution of particle fluxes and for obtaining additional information on the mechanisms of acceleration and leakage of high-energy particles. Figures 4; references 14: 6 Russian, 8 Western.

UDC 551.521.8

Correlation Between Electrical Field and Longitudinal Currents Determined From 'Intercosmos-Bolgariya-1300' Satellite Data
18660234f Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 9 Oct 86) pp 463-468

[Article by N. S. Nikolayeva, E. M. Dubinin, P. L. Izraylevich and I. M.Podgornyy]

[Abstract] The results of measurements of the electric and magnetic fields in the auroral region carried out by independent instruments on the Intercosmos-Bolgariya-1300 satellite are presented. It was found that in the region of flow of longitudinal currents there is a similarity of the profiles of electric and magnetic fields, which is evidently one of the manifestations of ionospheric-magnetospheric relationships when the closing of longitudinal currents occurs through meridional Pedersen currents and the Hall current is divergence-free. Pedersen conductivity is estimated in regions of proportionality of E_x and ΔB_y. The results of these computations are consistent with the conductivities obtained from the spectra of electrons measured simultaneously by this same satellite. A similarity between the ΔB_y and E_x profiles and the high degree of correlation between them, close to -1, are observed in all sectors of the auroral ionosphere, even during disturbed periods. The existence of a proportionality between ΔB_y and E_x means that the longitudinal currents are closed by meridional Pedersen currents. An impairment of correlation is possibly evidence of the partial nonstationary nature of the process or the contribution of Hall currents. Figures 3; references 16: 2 Russian, 14 Western.

UDC 531.36

Splitting of Separatrices and Generation of Isolated Periodic Solutions in Problem of Plane Periodic Motions of Satellite Relative to Center of Mass in Neighborhood of Collinear Libration Point

18660234g Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 10 Feb 88) pp 472-474

[Article by N. I. Churkina]

[Abstract] Plane periodic motions of a satellite relative to the center of mass in a periodic orbit close to the L_2 libration point in the circular three-body problem were examined. The problem was formulated by A. P. Markeyev in KOSMICH. ISSLED., Vol 17, No 3, p 333, 1979. It is assumed that satellite motion relative to the center of mass exerts no influence on its orbital motion and that the dimensions of the periodic orbit of the center of satellite mass are small in comparison with the distance between the points m_1 and m_2. Applying the Lyapunov holomorphic integral theorem, it is demonstrated that there are two families of periodic motions of a point of infinitely small mass near the L_2 libration point. A solution was found for one of these families of periodic motions for which the center of mass O of the satellite moves in the orbital plane of the finite masses m_1 and m_2, the distance between which is used as a unit length. It is assumed that the main central axis of inertia of the satellite Oy is at all times perpendicular to the orbital plane. References: 8 Russian.

Direct Measurements of Altitudinal Distribution of Nitric Oxide in Middle Atmosphere

18660234h Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 9 Feb 87) pp 474-477

[Article by G.A. Tuchkov and A.M. Zadorozhnyy]

[Abstract] The results of the first direct rocket measurements ofthe altitudinal distribution of nitric oxide in the range of 30-90 km, made using the RFI photoionization sensor, are presented. Measurements of NO in the atmosphere by the photoionization method are based on the selective ionization of nitric oxide molecules by vacuum UV radiation.The UV source used in the RFI sensor is a krypton resonance gas-discharge lamp. The RFI sensor was carried in the nose cone of a meteorological rocket. Four successful experiments (two series of two launchings) were carried out in December 1985 in the middle latitudes of the USSR. Data were obtained for both the ascending branch of the trajectory (higher than 60 km) and the descending branch. The results of these experiments are presented and compared with the results of other experiments and the theoretical profile; above about 70 km the NO concentrations were in good agreement with the maximal concentrations obtained by other authors; the results obtained in the range 30-70 km are also discussed, with possible explanations for deviations from the theoretical profile and earlier experiments. However, the construction of an adequate theoretical model of NO distribution in the middle atmosphere requires additional experimental data obtained under different heliogeophysical conditions. Figure 1; references 24: 7 Russian, 17 Western.

UDC 524.352

Polarimetry of Supernova 1987A: Observations and Interpretation

18660231 Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 14 No 5, May 88 (manuscript received 8 Feb 88) pp 387-393

[Article by A. P. Vidmachenko, Yu. N. Gnedin, V. M. Larionov and L. V. Larionova, Main Astronomical Observatory, Ukrainian Academy of Sciences, Goloseyevo; Main Astronomical Observatory, USSR Academy of Sciences, Pulkovo; Astronomical Observatory, Leningrad State University, Petrodvorets]

[Abstract] The results of spectropolarimetric observations of the SN 1987A made on the Bolivian expedition of the USSR and Ukrainian Academies of Sciences and Leningrad State University are analyzed,together with the results of wide-band polarimetric observations of other authors. Observations were made with a 60-cm Zeiss telescope. The contribution of interstellar polarization was eliminated from the results. It was found that the degree of polarization in the absorption lines is appreciably greater than in the continuous spectrum, evidence of strong stratification of the envelope; the region of absorption line formation has a greater asphericity than the region of formation of the continuous spectrum. Observations indicated the presence of a position angle jump of the polarization plane by 90° in the near-IR. Observations of circular polarization of this object indicated that the magnetic field strength in the envelope is less than 3 times 10^3 gauss. A direct correlation was established between the position angle of the polarization plane and the position of a compact object near SN 1987A; the origin of the latter may be associated with the formation of a bright hot spot in a jet of relativistic plasma ejected along the axis of star rotation (similar phenomena are observed in the nuclei of active galaxies). Confirmation must be obtained for the reality of the change in position angle within the absorption line. Figures 3; references 19: 6 Russian, 13 Western.

UDC 523.98527.75

New Topological Approach to Problem of Triggering of Solar Flares

18660230a Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 65 No 3, May-Jun 88 (manuscript received 14 Jul 86) pp 601-612

[Article by V. S. Gorbachev, S. R. Kelner, B. V. Somov and A. S. Shvarts, Moscow Physical Engineering Institute; Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences]

[Abstract] Magnetic field topology contains important information concerning the position and structure of

current systems in the solar atmosphere. This article gives a systematic study of topology of the stationary potential field formed by four compact spots in pairs with opposite polarity. It is shown that by examining the coordinates and the intensities of magnetic fluxes in spots as parameters and using the continuous dependence of the features of concern on these parameters, it is possible to trace the "dynamics" of generation and disappearance of these features. It is also shown that a slow change in the configuration of field sources can result in a restructuring of field topology. A separator does not always exist in this situation. During generation it is a line of force lying in the plane where the spots are situated. Then it rises over the photosphere, where the solar plasma is sufficiently rarefied that some form of plasma instability can develop. The strength of the longitudinal field on the separator is of fundamental importance because a strong longitudinal field considerably limits energy release in the current sheet. Small changes in the configuration of field sources can result in the appearance of an isolated zero point on the separator and its rapid movement along the separator. Over a long period of time the current sheet may therefore be stable and effectively accumulate energy, but the evolution of an active region can result in such a configuration that even small spot movements or fluctuation of fluxes in them result in a marked decrease of the longitudinal field on the separator and instability of the current sheet (which can result in a flare). Phenomena of such a type can be called the topological trigger of a solar flare, and they must be taken into account when constructing models of solar flares. Figures 5; references 29: 10 Russian, 19 Western.

UDC 52.854

Formation of Magnetic Filaments at Magnetospheric Boundaries of Solar System Planets

18660230b Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 65 No 3, May-Jun 88 (manuscript received 2 Jul 86) pp 626-636

[Article by L. M. Zelenyy and M. M. Kuznetsova, Space Research Institute, USSR Academy of Sciences]

[Abstract] The theory of spontaneous localized reconnection at the magnetospheric boundaries of solar system planets having a strong internal magnetic field was studied in detail. Such forms of reconnection (FTE—flux transfer events), resulting in the formation of magnetic filaments, have been registered by satellites in the magnetospheres of the Earth, Mercury and Jupiter. The physical factors controlling the temporal and spatial scales of this phenomenon as a function of distance from the planet to the sun (solar wind parameters) and the planetary magnetic dipole moment are discussed. Theoretical estimates of the characteristic diameters of magnetic filaments for the Earth, Mercury and Jupiter are in satisfactory agreement with experimental data. Materials are presented which indicate that the formation of magnetic filaments is a fairly common phenomenon, at least for solar system planets. The FTE theory indicates that the conditions for the formation of magnetic filaments are determined by two processes: diffusional magnetic percolation, which has a complex stochastic nature, and hydrodynamic convection. Depending on the physical parameters (planetary magnetic field and the solar wind flow around it), the influence of convection on FTE may be greater (Mercury) or less (Jupiter, Saturn). The Earth's magnetopause is an intermediate case, with these two effects being commensurable in magnitude. Typical FTE parameters for Saturn and other astrophysical bodies are estimated. Figures 2; references 24: 6 Russian, 18 Western.

UDC 520.16

Multifaceted Research on Optically Active Atmospheric Turbulence at Two Mountain Observatories

18660230c Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 65 No 3, May-Jun 88 (manuscript received 3 Mar 86) pp 637-644

[Article by A. E. Guryanov, B. N. Irkayev, M. A. Kallistratova, M. S. Pekur, I. V. Petenko, V. P. Rylkov, A. A. Semenikin, N. S. Time, Ye. A. Shurygin and P. V. Shcheglov, Atmospheric Physics Institute, USSR Academy of Sciences; Astrophysics Institute, Tajik Academy of Sciences; Main Astronomical Observatory, USSR Academy of Sciences; State Astronomical Institute imeni P.K. Shternberg, USSR Academy of Sciences]

[Abstract] The method for acoustic sounding of the atmospheric boundary layer in the altitude range 34-680 m, together with photoelectric observations of trembling of the star image and surface microtemperature measurements, was used for the first time in astroclimatic research. It was found that during clear nights the characteristic intensity of optically active turbulence in the boundary layer over Mount Sanglok (Tajik SSR) is an order of magnitude lower than at other measurement points (other than Mauna Kea). The use of the method made it possible to estimate the relative contribution of the lower part of the atmospheric boundary layer to atmospheric distortions of the astronomical image. This contribution was very low during observations on Mount Sanglok, whereas measurements at the Special Astrophysical Observatory indicated that this contribution is at times decisive. For both observatories the surface atmospheric layer plays a small role in distortion of the astronomical image at nighttime in comparison with the effect of the entire atmospheric layer. In order to clarify the mechanisms of formation of a high atmospheric quality of the astronomical image it is important to examine the relative contribution of the boundary layer to atmospheric distortions at other Central Asian observatories and ascertain whether the small contribution of this layer is a peculiarity characteristic only of Mount Sanglok. Figures 4; references 21: 16 Russian, 5 Western.

UDC 523.46

Equatorial Acceleration as Result of Differential Buoyancy of Eddies. Observational Confirmation Using Example of Saturn

18660230d Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 65 No 3, May-Jun 88 (manuscript received 21 Jul 86) pp 655-659

[Article by E. M. Drobyshevskiy, Physical-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences]

[Abstract] The results of computations of the intensity and width of the equatorial jet of Saturn made by the author prior to the flight of Voyager on the basis of the assumption of transport of angular momentum as a result of the different buoyancy of oppositely rotating eddies are compared with actual Voyager measurements. It is now confirmed that the principal reason for the equatorial acceleration of turbulent atmospheres is the transport of angular momentum caused by the different buoyancy of oppositely rotating convective (turbulent) eddies. The length of the "mixing path" for convective elements is two heights of the homogeneous atmosphere. The surfaces of constant angular velocity are close to cylindrical. The thickness and width of equatorial currents on the giant planets are determined by the depth at which the inner magnetized ionosphere, generated by thermal ionization (and not a metallized core, as postulated earlier), rotates synchronously with the magnetic field. Figure 1; references 33: 9 Russian, 24 Western.

UDC: 523.68

'Vega' and 'Giotto' Missions: A New View of Solar System Structure

18660187e Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 14, No 4, Apr 88 (manuscript received 9 Nov 87) pp 379-382

[Article by L. S. Marochnik and L. M. Mukhin, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] If the mass and albedo of the nucleus of Halley's comet are typical for other short-period comets, on the periphery of the solar system in the Oort cloud there is a concentration of mass of approximately $1/4\Sigma Mp$ (ΣMp is the total mass of the planets) and possibly an angular momentum exceeding by an order of magnitude the present-day angular momentum of the planetary system. The present-day angular momentum of the Oort cloud is of the same order of magnitude as the total angular momentum of the planetary system prior to the loss of its volatiles. Therefore, it seems evident that most of the present-day angular momentum of the solar system is probably not contained in the planets, as was assumed earlier, but at its periphery, and the total angular momentum of the solar system is an order of magnitude greater than when it was considered to be 98percent concentrated in the planetary system and 2percent in the sun. If there is validity to the hypothesis of a so-called internal cometary reservoir (a subject not examined in this article), the present-day structure of the solar system differs still more radically from that which has been assumed. References 29: 8 Russian, 21 Western.

UDC 523.34

Research on Temperature Variations of Lunar Surface at Short Centimeter Wavelengths With RATAN-600

18660002a Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 14, No 6, Jun 88 (manuscript received 19 Nov 87) pp 553-563

[Article by M. N. Naugolnaya and N. S. Soboleva, Special Astrophysical Observatory, USSR Academy of Sciences, Nizhniy Arkhyz village; Leningrad Affiliate, Special Astrophysical Observatory, USSR Academy of Sciences, Pulkovo]

[Abstract] Since 1977, extensive data on characteristic lunar radio emission at wavelengths 1.35, 2.08, 3.9, 8.2, 13.0 and 31.3 cm have been obtained with the RATAN-600 telescope with a considerably higher sensitivity than in earlier observations and with a resolution which had not previously been attained in constructing the lunar radio image (at the shortest wavelength the resolution was 5" x 40", which corresponds to linear dimensions 3.5 x 30 km). Observations were made during a series of lunations. Data were obtained on deviations of temperature variations from the means in different regions of the lunar surface. The most surprising finding was that in contrast to the observations of the 1960's, which were with moderate sensitivity and resolution, the distribution of lunar radio brightness was extremely nonuniform. Nonuniformities with a wide range of scales were discovered. The repetition of these distributions obtained precisely after a lunar month demonstrates the validity of these findings. The article gives an analysis of the most distinct details, making it possible to trace the dependence of brightness on lunar phase. A table gives the characteristics of a series of lunar surface regions observed at 1.35 cm. The following factors appear to explain the differences in the temperature regime in the radio range in such regions: purely geometrical factors, such as steep surface slopes, and differences in the physicochemical properties of different surface sectors (surface emergence of layers with a high density, considerable difference in heat flow from beneath surface layers, difference in permittivity, difference in chemical composition of maria and continents). Figures 5; references: 18: 15 Russian, 3 Western.

UDC 523.68

'Vega' and 'Giotto' Mission: Does Invisible Mass Exist in the Solar System?

18660002b Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 14, No 6, Jun 88 (manuscript received 9 Nov 87) pp 564-568

[Article by L. S. Marochnik and L. M. Mukhin, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] In a previous article by the authors (PISMA V ASTRON. ZHURN., No 4, 1988) the high mass found for the nucleus of Halley's comet and its low albedo are

indicative of the great mass of the Oort cloud and a high angular momentum concentrated in it, provided that it is postulated that the nuclei of new comets are close in mass to the nucleus of Halley's comet. This led to the radical conclusion that the present-day structure of the solar system must be visualized completely differently than previously accepted: on its periphery there is concentration of a great mass, and virtually all solar system momentum, which is an order of magnitude greater than that which is concentrated in the planets, is present there. Proceeding on this basis, it is now shown that the distribution of mass and angular momentum still more radically differs from that commonly accepted. If the Oort cloud is only a halo surrounding the dense internal cometary core and if the mass of the nucleus of Halley's comet is also typical for comets populating the core, in the region of heliocentric distances 2 x 10^3 less than or equal to r less than or equal to 2 x 10^4 AU there may be an invisible mass (in the form of cometary nuclei) (M_{core} is approximately 0.03 M_{sun}), possibly having an angular momentum about 10^{53} g x cm^2/s. Since the mass M_{core} is on the order of the total mass of the planetary system before the loss of its volatiles, in the course of evolution of the protosolar nebula approximately identical masses entered into the formation of planets and comets. References 23: 4 Russian, 19 Western.

UDC 523.7

Structure of Thermal Waves in High-Temperature Flare Plasma

18660002c Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 14, No 6, Jun 88 (manuscript received 14 Dec 87) pp 569-576

[Article by A. G. Kosovichev, Crimean Astrophysical Observatory, USSR Academy of Sciences, Nauchnyy village]

[Abstract] Research was conducted with numerical simulation of the processes of formation and propagation of thermal waves during impulse energy release, specifically in relation to high-temperature plasma (T_e about 107 K, n_e about 10^{10} cm^{-3}) during the time of solar flares. A study was made of the effects of thermal flux saturation and the heating of ions. The results of this simulation indicated that the structure of thermal waves in high-temperature flare plasma is considerably influenced by the effects of relaxation of the thermal flux. Two different heat transfer modes are possible, depending on the rate of release of the thermal energy of flares. With the rapid release of thermal energy during a time τ_0 less than the characteristic relaxation time τ of the heat flow, a traveling high-temperature impulse with a steep leading edge is formed whose structure is determined by ionosonic turbulence. In the case of slow energy release (τ_0 greater than τ) heat transfer is by a thermal wave with a monotonic temperature distribution. In such a case the intensity of plasma emission in the soft x-range is substantially greater. Figures 4; references 18: 7 Russian, 11 Western.

UDC 512.2

Universal Solution of Lambert Problem

18660008a Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 17 Sep 86) pp 483-491

[Article by A. A. Sukhanov]

[Abstract] A detailed derivation is given for a single equation whose root gives a solution of the Lambert problem. A universal approach is applied for this purpose. The new equation is given in both Stumpff and Bettin functions and in its form is somewhat simpler than the equation derived by J. Kriz, "A Uniform Solution of the Lambert Problem," CELEST. MECH., Vol 14, pp 509-513, 1976. An investigation of this equation is made, an algorithm for its solution is outlined and the necessary formulas for finding the sought-for orbit are given. The merits of the proposed method for solving the Lambert problem are its simplicity and at the same time, its universality. It is suitable for any types of orbit and also for multi-revolution orbits with any number of full revolutions. Figures 2; references 8: 5 Russian, 3 Western.

UDC 629.7

Periodic Oscillations of Satellite-Gyrostat Relative to Center of Mass Under Influence of Aerodynamic and Gravitational Moments

18660008b Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 17 Nov 86) pp 492-507

[Article by V. V. Sazonov and A. A. Voronin]

[Abstract] A satellite-gyrostat, such as examined in the article, is a solid body within which there is a rotating symmetric rotor. It is assumed that the kinetic moment of the rotor relative to the carrying body is constant and parallel to one of the main central axes of satellite inertia. The external shell of the body is assumed to be a sphere whose center lies on another main axis of inertia. A circular Keplerian orbit is considered. The rotation of such a satellite under the influence of aerodynamic and gravitational moments is examined for a case when the kinetic moment of the rotor and the aerodynamic moment are large. The formulated problem arises as a natural idealization in an analysis of the aerogyroscopic orientation system on the "Cosmos-149" and "Cosmos-320" satellites. The motion of such a satellite-gyrostat is described by an independent system of sixth-degree differential equations. This system of equations contains a large parameter. Analytical and numerical methods are used in investigating symmetric periodic solutions of this system close to periodic solutions of the corresponding degenerate system, whose order is equal to 2. The results make it possible to understand the characteristics of perturbed motion of satellites with an aerogyroscopic orientation system. Figures 6; references: 11 Russian.

UDC 629.78.086

Solution of Problem of Approach to Several Asteroids Using Optimal Correction Algorithm

18660008c Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26, No 4, Jul-Aug 88 (manuscript received 25 Nov 87) pp 508-518

[Article by V. A. Zhirnov and M. L. Lidov]

[Abstract] An interactive procedure is described for solving the problem of approach to N asteroids of the main belt. The approach is accomplished by means of jet impulses with a total expenditure of characteristic velocity w not exceeding 1 km/s after a flight originating on Mars. The problem of the choice of definite asteroids and programs of impulses minimizing w is solved. A simplex algorithm for optimal linear pulsed correction (M. L. Lidov, KOSMICH. ISSLED., Vol 9, No 5, p 687, 1971) is used for minimizing w. The effectiveness of the proposed approach is demonstrated in numerical examples of solution of one methodological variant of the problem for N = 2, 3, 4. In the future the method for solving the problem can undoubtedly be modified and its effectiveness increased. References: 3 Russian.

UDC 519.68

Ellipsoidal Guaranteed Evaluations of State of Dynamic System

18660008d Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 24 Nov 86) pp 519-526

[Article by A. F. Bragazin and N. P. Shmyglevskiy]

[Abstract] An algorithm for the guaranteed evaluation of the vector of state of a linear dynamic system is written on the basis of component-by-component processing of measurements of its output, considered as a series of scalar measurements, and additive perturbations. A set of admissible records of the measurement result in evaluation space is approximated by a zone bounded by two parallel hyperplanes. Such an approximation is correct with component-by-component processing of measurements of the vector value if its region of indeterminancy is majorized by the intersection of the zones for each component. After processing of the scalar measurements the region of indeterminancy of the vector of state is determined on the basis of precise solution of the problem of minimizing the volume of a multidimensional ellipsoid containing the intersection of the initial ellipsoid and the zone (discussed by N. Z. Shor, et al. in KIBERNETIKA, No 4, pp 62-67, 1979). An arbitrary vector of perturbations is majorized by the sum of the vectors which in evaluation space have a determined direction and an arbitrary limited length. The influence of each of these vectors is taken into account successively. In this case a precise solution of the problem of minimizing the volume of the ellipsoid majorizing the sum of the initial ellipsoid and segment is used. Applying this approach, an example of evaluation of the velocity parameters of an artificial earth satellite orbit on the basis of altitude measurements is given. Figures 4; references 8: 7 Russian, 1 Western.

UDC 629.197.2

Optimal Pulsed Transfers Between Noncoplanar Elliptical Orbits

18660008e Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 30 Sep 85) pp 527-534

[Article by V. I. Gulyayev, V. L. Koshkin and Ye. O. Terekhova]

[Abstract] A study was made of optimal spatial transfers of spacecraft in a central force field with a stipulated maneuver time. In a two-impulse formulation the problem of optimal transfer between fixed points in a central Newtonian field during a stipulated time is reduced to solution of the Lambert problem. One of the most effective numerical methods for determining optimal multi-impulse trajectories which has been proposed for increasing the number of impulses involves use of information on behavior of the modulus of the base vector on a nonoptimal trajectory and requires repeated solution of the Lambert problem and application of a heuristic approach in selecting the initial N-impulse trajectory in each interval of the iteration process. However, if points on limiting orbits are free and are selected optimally, methods based on solution of the Lambert problem are less effective. Accordingly, a numerical method is proposed for determining the optimal pulsed spatial transfer of a spacecraft between orbits with a stipulated time and optimal choice of points of departure from the initial orbit and arrival in the final orbit. The problem is solved for both free and stipulated transfer times and the results of numerical investigation of the influence of transfer time and the parameters of limiting orbits on the characteristics of an optimal maneuver are given. Figures 3; references 10: 9 Russian, 1 Western.

UDC 531.352

Analogues of Triangular Libration Points in Restricted Three-Body Problem With Allowance for Tidal Effects

18660008f Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 20 Jan 87) pp 535-541

[Article by K. M. Lebedev]

[Abstract] Triangular libration points in the classical restricted three bodies problem are stable with certain relations between the masses and eccentricities of the orbits of the main two bodies, but this stability is not asymptotic and has the nature of gyroscopic stabilization. In the solar system there are small dissipative forces operative, for example, of a tidal nature, under whose

influence this stability can be impaired. A very simple model of such a situation is examined. It is assumed that the main bodies are material points with the masses (M-μ) and μ, moving in circular orbits relative to a common center of mass with a stipulated mean motion. The third passively gravitating body is a viscoelastic sphere of Kelvin-Voigt material having the mass m. This circumstance adds additional degrees of freedom to the problem associated with rotation of the sphere about its center of mass. The plane problem is solved: the center of mass of the sphere moves in the plane of points (M-μ) and μ and its kinetic moment is parallel to this plane. With this formulation of the problem it was possible to find analogs of Lagrangian equilibria and demonstrate their instability. References: 3 Russian.

UDC 535.24:523.42

Spherical Harmonics Method: Application to Transfer of Polarized Radiation in Vertically Inhomogeneous Planetary Atmosphere. Mathematical Approach

18660008g Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 14 Jul 87) pp 550-562

[Article by Ye. A. Ustinov]

[Abstract] A generalization of the spherical harmonics method is proposed for solving the equation for the transfer of electromagnetic radiation with polarization taken into account. Until now the method has been generalized only for the special case of incidence of nonpolarized radiation on a homogeneous scattering medium, when the first two components of the Stokes vector are adequate for the description. In order to broaden its possibilities, the spherical harmonics method has now been generalized for the arbitrary case of scattering of solar radiation in a plane-parallel atmosphere with a phase scattering matrix dependent on altitude. The same form of exposition is used as employed by J. V. Dave (J. ATMOS. SCI., Vol 32, No 4, pp 790-798, 1975), where a similar general case is examined applicable to a scalar description of radiation scattering. The new generalization is applicable to models of plane-parallel atmospheres with an arbitrary vertical inhomogeneity. The angular dependence of the solution is represented in the form of an expansion in generalized spherical functions. The principal relations of the method are derived. The appendices give descriptions of the SP representation that was used for the vector of radiation intensity and also of the functions employed. Figures 2; references 17: 9 Russian, 8 Western.

UDC 543.42:522.124

Secondary High-Energy Electrons (10^7-10^8 eV) in Near-Earth Space

18660008h Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 24 Mar 87) pp 563-568

[Article by N. L. Grigorov, L. V. Kurnosova, L. A. Razorenov and M. I. Fradkin]

[Abstract] There are two different mechanisms which can explain experimental data on secondary high-energy electrons in near-Earth space. The basis for both mechanisms is the process of interaction of primary cosmic rays with the atmosphere in different altitude intervals. The first mechanism was discussed in detail by N. L. Grigoryev et al in TR. FIAN, Vol 162, pp 101-141, 1986; this article is devoted to the second. At altitudes up to 500-600 km the mechanisms of inelastic interaction between cosmic rays and the residual atmosphere and the generation of π and K mesons, whose decay gives rise to high-energy electrons, are operative. The flux of these electrons is not dependent on atmospheric density. With a low-density residual atmosphere, the mechanism of formation of high-energy electrons as a result of the decay of radioactive fragments of cosmic ray nuclei that form during the interaction of primary nuclei in the stratosphere enters into operation. In this case the electron flux is inversely proportional to atmospheric density. These two processes of interaction between primary cosmic rays and the low-density atmosphere can for the most part explain all the presently known information on high-energy electrons with tens and hundred of MeV observed in near-earth space both under the radiation belts and in the inner radiation belt, without invoking additional acceleration mechanisms. Figures 2; references 9: 8 Russian, 1 Western.

UDC 581.521

Ions With Energies 0.03-50 MeV in High-Latitude Ionosphere

18660008i Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 12 Nov 86) pp 569-577

[Article by M. I. Panasyuk and V. P. Pishchikov]

[Abstract] The article gives an analysis of the spectral characteristics of protons in the energy range 0.03-50 meV observed beyond the boundary of stable capture on the nighttime side of the polar ionosphere during the time of substorms and during magnetically quiet periods. The observations were made on the "Cosmos-900" artificial earth satellite in a circular polar orbit with an altitude of about 500 km. During a substorm the spectra of protons in the polar ionosphere region have a complex structure. The low-energy bi-Maxwellian sector has an intramagnetospheric origin, whereas the high-energy power-law sector has an extramagnetospheric origin. The spectral parameters of the proton fluxes in a magnetically quiet period differ from those in a substorm period. The spectra in an undisturbed period in the entire investigated energy range (E about 30-300 keV) are described by a power function with γ about 3-6 and (or) a Maxwellian function with E_0 about 5-10 keV. The greatest difference in the disturbed and undisturbed spectra is observed in the energy range greater 100 keV. The data are compared with the results of spectral measurements of protons in the geomagnetic tail and in existing models of generation and propagation of particles in the Earth's magnetosphere. Figures 5; references 29: 8 Russian, 21 Western.

UDC 551.521.8

Spatial Distribution and Dynamics of Longitudinal Currents During Magnetic Disturbances Determined From Observations on 'Intercosmos-Bolgariya-1300' Artificial Earth Satellite

18660008j Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 2 Sep 86) pp 604-613

[Article by V. I. Lazarev, M. V. Teltsov and S. I. Shkolnikova]

[Abstract] On the basis of the results of joint measurements of the magnetic field and fluxes of charged particles with E less than or equal to 15 keV and greater than or equal to 0.4 keV penetrating into the ionosphere and registered on the "Intercosmos-Bolgariya-1300" artificial Earth satellite, a study was made of the spatial distribution and structure of longitudinal currents during the time of substorms. The magnetic field disturbances in the daytime sector reveal a substantially different behavior of current systems in comparison with other MLT sectors. During disturbances the currents increase in intensity and the region of their existence broadens, but the current system existing under these circumstances under quiet conditions also persists when there is a high level of magnetic disturbance. At the substorm maximum there is no such stratification of the longitudinal currents in which the calm structure of the longitudinal currents would completely disappear. The experimental data collected in different time sectors made it possible to investigate the relationship between the positions of the auroral oval, whose boundaries were determined from the increase in the flux of leaking auroral electrons, and longitudinal currents during the time of a substorm. In the morning, nighttime and evening MLT sectors the two- or three-layer system of longitudinal currents characteristic for a quiet period is replaced during the time of substorm development by a multilayer system. The longitudinal currents flowing from the ionosphere coincide well with the leakage of high-energy (1-3 keV) electrons. A statistical scheme of the distribution of longitudinal currents during different substorm phases is proposed. Figures 5; references 17: 9 Russian, 8 Western.

UDC 551.510.536

Initial Chemical Composition and Tests of Atmospheric Disturbance From Source of Ultraviolet Radiation

18660008k Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 12 Aug 87) pp 614-620

[Article by Yu. M. Grishin, N. V. Yeliseyev, V. A. Kiselev, N. P. Kozlov, S. I. Kozlov, A. I. Livshits and Yu. S. Protasov]

[Abstract] The spatial distribution of the initial chemical composition of air arising under the influence of a source of ultraviolet radiation with different spectral and energy characteristics was computed for a broad range of wavelengths and altitudes. These computations were used in formulating disturbance criteria, and data on the source parameters optimal for the occurrence of disturbances corresponding to each criterion are given. The radiation source is considered a point source because its size is much smaller than the size of the region which it disturbs, and the radiation spectrum conforms to the radiation of an ideal black body with the corresponding brightness temperature 10^4-10^5 K. All computations are made on the assumption of an instantaneous energy release. The computations were made for the altitude range 30-400 km (separately for 30-90 and 90-400 km) in the Earth's atmosphere. The initial chemical composition can vary somewhat due to the contribution of photoelectrons, correct allowance for which requires further investigations. The process of further relaxation of the parameters to the natural level and the specific characteristics of the diagnostic tools for observing the disturbed region may impose additional requirements on the atmospheric disturbance criteria, and accordingly, on E. Figures 3; references 12; 7 Russian, 5 Western.

UDC 543.42:522.124

Fluxes of Intermediate Nuclei in Near-Earth Artificial Earth Satellite Orbits

18660008l Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 20 Apr 87) pp 636-638

[Article by R. A. Nymmik, A. M. Marennyy and G. P. Gertsen]

[Abstract] An experiment on Skylab-3 in 1973-1974 revealed anomalously high fluxes of intermediate nuclei in near-Earth satellite orbits. There has been little clarification of this matter since that time because subsequent experiments were made under changing solar activity conditions. This article discusses measurements of fluxes of intermediate nuclei obtained 11 years later in the new solar cycle. Fluxes of these nuclei with energies 4-16 MeV/nucleon were obtained in experiments with the "Cosmos-1571," "Cosmos-1672" and "Cosmos-1715" satellites. Stacks of detectors were held in special containers attached to the outer surfaces of these satellites; the container covers were opened when the satellites were in orbit. During the years 1985-1986, during the corresponding solar activity minimum, particle fluxes of the anomalous component, approximately equal to those observed in 1973-1974, were detected beyond the limits of the Earth's magnetosphere, but at altitudes 200-400 km there were no excess fluxes of intermediate nuclei whose intensity would be close to those registered on Skylab-3. This indicates that the mechanism of capture and accumulation of particles of the anomalous component in the radiation belt by a sharp change in their ionization state upon reaching low altitudes in the region of the South Atlantic magnetic anomaly cannot explain the appearance of the excess fluxes of intermediate nuclei in the Skylab orbit. Figures 2; references 11: 1 Russian, 10 Western.

Interview With Designer of Buran Automated Landing System

18660020 Leningrad LENINGRADSKAYA PRAVDA in Russian 1 Dec 88 p 2

[Interview by LENINGRADSKAYA PRAVDA correspondent with Gennadiy Nikolayevich Gromov, doctor of technical sciences and general designer of electronic systems for air traffic control, navigation, and landing of the Buran craft; "'Buran': A Leap From Space"; first four paragraphs appear in boldface in source]

[Text] **"In the TASS reports on the orbital shuttle craft, in the reports from the cosmodrome, we've constantly heard: 'The world's first automated landing has been made.' We know that this achievement bears a direct relationship to Leningrad and to the group with which you work."**

"Yes, and Leningraders can be absolutely proud of the work done by their fellow townsmen. The fact is that the complex we've named 'Vympel' was the one that provided the support for what we have come to understand as the automated landing of the orbital craft. The complex was created through the collaboration of many enterprises, with our All-Union Scientific Research Institute of Radio Apparatus playing a coordinating role. From conception to requirements specifications, we completely covered the entire cycle of development, including today's successful completion."

My conversation partner is G. N. Gromov, a Leningrader, doctor of technical sciences, general designer of the electronics systems for air traffic control, navigation, and landing of the craft.

Finding Gennadiy Nikolayevich in the days after the flight was hard. His movement about, it seemed, was unpredictable. He might be with colleagues at the parent enterprise, he might be at the educational institute, he might be at the City Council of People's Deputies. When he would appear for a time on his own turf, he would be in an environment dense with people and goings-on. The day we finally managed to "hook up" was just as stormy as that memorable day of November 15. At that time, we all were the first to see on our television screens the black-and-white aircraft dropping out of the clouds, the intrepid landing with the steeply up-turned nose, and the seemingly slow-motion, thoughtful movement right before it stopped. Now we can hear the details firsthand.

"Precision Akin to a Jeweler's"

"I would like to turn your attention to the main, decisive point: the landing was **pilotless in the gliding mode.**" With those words, G. N. Gromov stepped up to a huge schematic. "That is, automated landings of aircraft like this have been done before; but in this one, there was no pilot whatsoever. There was no pilot aboard our orbital craft. In exiting the plasma—in other words, after passing through the upper layers of the atmosphere, where the braking element heats up and molecular bonds are destroyed—Buran had a great deal of kinetic energy. Its engines were not switched on. From an altitude of more than 40 kilometers and a range of 400-500 kilometers, it had to touch down on the specified landing strip, with no possibility of making another orbit. And this craft, even when piloted, cannot make another orbit. Landing is its only option.

"Why, this problem will certainly be solved in the future. The shuttlecraft will be able to make its landing approach more than once and, maybe, even take off from a runway. For the time being, neither our shuttle nor the Americans' can do this. What's more, the fuel allotment isn't enough for such maneuvers. After all, the fuel just makes for additional launch weight. And it's a dangerous 'load' when the craft is landing."

Correspondent: **Just what kind of precision work must there be to enable such a leap from cosmic heights on the first try?**

"First of all," Gromov said, "you need a complex of ground-based and on-board systems. Landing is a maneuver that involves more than the dissipation of power; it also involves intricate evolutions that enable the craft to exit to a predetermined point and then to touchdown immediately. And if the automated landing of piloted aircraft, as we've known it up to now in aviation, has been done via the interaction of electronic systems 10-15 kilometers from the landing strip and at altitudes no greater than a kilometer or two, here it begins virtually in the heavens. Up there, no one, save for the equipment of our Vympel complex, can see or hear the aircraft. The first to detect it are our radars, and then the highly precise, distributed, rangefinder radar navigation system goes into operation.

"The craft does some intricate flying at that point. It is subjected to various oscillations, and the characteristics of its motion may differ substantially from the prescribed characteristics. If the parameters of its motion aren't corrected, the craft will not exit to the predetermined point. So, guided by an on-board computer complex, it begins to slide along the surface of an invisible cylinder for dissipating its power, and the electronic landing system picks it up, in fact, at an altitude of about 7 kilometers. This system is of extremely high accuracy and is all-weather, enabling a landing even in the complete absence of visibility, and it makes it possible to land Buran with virtually a jeweler's precision. When the craft came to a stop, it had deviated only a few dozen centimeters from the centerline of the runway."

The First Buran Crew

Correspondent: **The landing is not all the Vympel can do. It tracks the craft during flight in the atmosphere, aims the antennas of the telemetry and television systems, controls the vectoring of the spotter aircraft, and monitors the airspace to ensure the safety of the craft arriving from space.**

But it wasn't for nothing, at the press conference with the Soviet-French crew right after the Buran flight, that Jean-Loup Cretien (whom we saw on television delightedly give the thumbs-up sign) uttered: "The most impressive thing was the landing. It was as if a pilot were sitting in the cabin!" And, perhaps he wasn't that far from the truth. Aboard the craft was a sort of presence that had absorbed the minds, the talents, the instincts, the hands of its creators. Just who was that presence, that first Buran "crew"?

"Guiding the aircraft that time," Gromov said, "was a huge group of developers. Primarily, of course, they consisted of the creators of the glider craft, the on-board systems, and the electronic guidance systems. Because the business of landing—automated, pilotless—could not have been done without their high-quality work. Because we can each do our job excellently, but if someone somewhere doesn't make allowances for the properties of the other systems, we won't achieve overall success. This is the most important aspect in the creation of any large system. And this space system is grandiose: it consists, in fact, of Vympel, the orbital craft, and the ground complexes."

Correspondent: **The All-Union Scientific Research Institute of Radio Apparatus group—the people who took part in developing this program—were also part of this invisible crew. Did their getting the task of performing this work stimulate them to some sort of special achievement? Certainly, the institute had the resources for such an assignment, didn't it?**

"The group has been at the cutting edge of things for many years now," Gromov said. "In the last decade, we have introduced microelectronic technology on a very wide basis, and we've released into production a whole gamut of state-of-the-art on-board devices. We haven't been embarrassed about showing our equipment to our American colleagues who, when they visit us, see our devices and take them into their hands and say, 'Yes, these are among the best.'

"Portions of flexible manufacturing systems, concepts 'from display to machine tool'—there were many such solutions that accumulated gradually. But a certain kind of goal was needed, and then the impetus that would make it possible to throw all the accumulated experience into the creation of the most complex of systems. Such a goal was the creation of the Vympel electronic systems complex for Buran. It included many original solutions that were brought about expressly for, and were stimulated by, that system. In general, everything that was planned in the technical requirements was produced one for onee, and now has been tested, and may be used in the economy. We started on this path as novices, but we will leave as experienced developers and experimenters."

Correspondent: **The working day would end. The square of the institute's courtyard outside the window, unpeopled for the time being, seemed like an eye looking into the sky. The hexagonal fountain, spraying like a snow blizzard, represented the launch site (or could it have been the landing site?) of some craft. And the innumerable windows—casting lively, warm light—reminded one of a gigantic computer complex. Behind every window, the people continued their work.**

"And the people?" the general designer said, as if continuing my train of thought. "Our people are remarkable. Many are devoted to their group and have gone the entire route here—from being a young specialist to becoming a chief designer.

"Chief complex and systems designers R. V. Drozdov and Yu. S. Filaretov helped develop the space program. The deputy chief designer for the electronic landing system, M. D. Maksimenko, was first involved with on-board gear only, and then we set up a department that included all the gear—on-board and ground-based. That is, in addition to creating the complex, we recast our organizational structure so that it would best satisfy developmental needs. I can't imagine Vympel without deputy chief designers Yu. M. Andreyev and V. I. Spivak, without the advances made in the laboratory of O. L. Kesselman. But I would say this much: they are still systems people. Whereas there are also people who develop instruments. For example, fundamentally new solutions have been found in G. I. Ukolov's department, in which B. N. Chernyshev and S. S. Rogulin work. The antenna sector was developed by M. Ye. Chuprov and Ye. V. Abramov-Maksimov. (By the way, there's a telegram in my office that says that Abramov-Maksimov was recently awarded the State Prize for one of his past efforts.) We have designers, metrologists, production engineers, experimenters—you name it. The director of the All-Union Scientific Research Institute of Radio Apparatus (VNIIRA), V. K. Yaremich, before his appointment to that post, was chief of the department of flight research, which made a colossal contribution to the whole affair."

Correspondent: **But didn't this most intricate mechanism of a complex have to be "brought to life," made to work efficiently? Didn't some prescribed program of action have to be incorporated into it, as well as the ability to make flight corrections conforming to the program?**

"In other words," Gromov said, "create software. The splendid specialists B. A. Lapin, S. N. Losev, and Sasha Ostanin —a young and, one might say, youthful engineer—created magnificent technology. The computer and research subdivisions produced a half-scale simulation stand for debugging on-board instrumentation, a stand that made it possible to expose all the equipment to any situation and any trajectory. You use the rig to test whatever you need to test, and you get its 'worth'—all its faults, its internal structure, and so forth.

"And what would we be able to do without those who put the products together? You know yourself that this is a vulnerable area: everything must be ordered and received on time. A huge group, in your words, has 'flown into space.' The workers and installers were side by side with us in creating this whole complex organism."

For Future Flights

During the work on the Vympel complex, there was, in the words of Gennadiy Nikolayevich, a constant flow of information. Without studying the literature, without knowing what was going on in the world, it would have been impossible to create an evolving system of such complexity. The developers more than once showed similar equipment to their foreign partners, with whom they had international ties, and they took into consideration the evaluations given by key specialists from western firms. All this went into a receptacle for general knowledge and achievements of the enterprise. Now the entire huge group has "returned to the homeland" after the ever increasing stress of recent months. Without a respite, it has engaged in earthly pursuits. The pilots are preparing take their places in the cabin of Buran.

Correspondent: **What kind of relationships do the pilots have with the developers of the equipment? What will the landing complex do in the piloted mode?**

"The relationships," Gromov said, "have evolved gradually, from training session to training session. After all, our equipment makes it possible to refine the interaction between ground-service operators and the crew. We have put the test pilots through various situations, including those with the spotter aircraft. And during Buran's flight, Igor Volk—cosmonaut and chief of the future pilots of the orbital craft—stood right behind me, peering at the displays and following how things were done and who did them. Maybe he was going over his own future flight, imagining how the system and the operators would work with him in the matter. The crews are preparing for the flight, and our contact with them has, naturally, done a lot both for them and for us.

"Strictly speaking, the piloted variation will not alter the functions of the complex. The fact is that **the landing of the piloted orbital craft will also be done wholly in the automated mode.** For the flight reliability and safety, the equipment is backed-up several times over. In addition, if any device fails, another assumes its functions. So, when landing, the crew is 'disengaged' from active participation in the control of the craft. Of course, there could be situations serious enough for the crew to have to take control of the craft; but such situations are the exception, not the rule. The guys will have plenty of work in orbit, so let the automatic equipment give them some support during this stage."

Correspondent: **By the way, about the operation in orbit of a shuttlecraft. The question has already come up in the press, specifically in the LITERATURNAYA GAZETA, asking whether a Soviet shuttle is needed.**

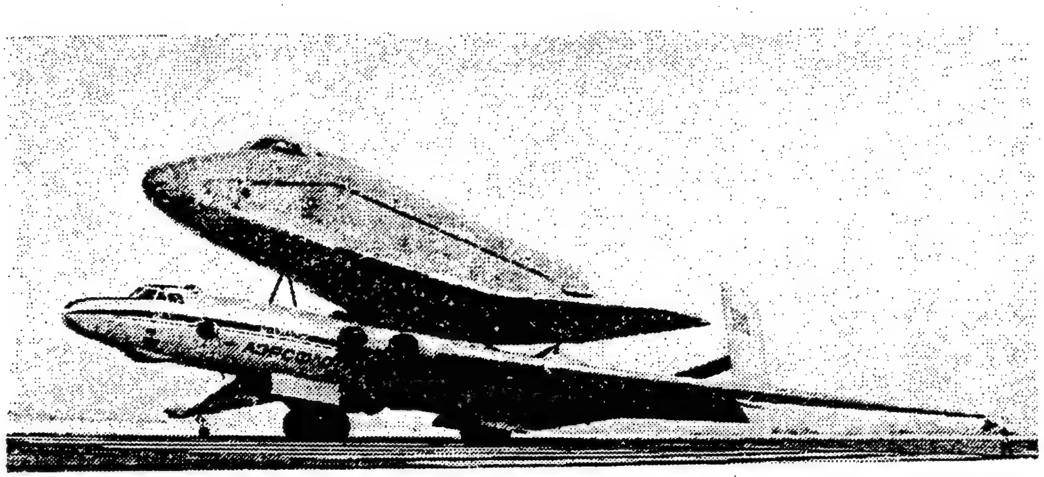
"From the standpoint of the electronics systems complex that we created for the orbital craft," Gromov said, "I've never had any doubt about whether we need it. It is technology that meets the needs of the country. The instruments will be put to use, and have already been put to use, in the economy. The experience we've gained is hard to overvalue. The development of the huge system for supporting all-weather landings will also be used in the sphere of aviation. Reliability and quality of execution make this possible.

"From the standpoint of the orbital craft itself, this is a grand, necessary technical achievement. The operations that Buran will perform are already being designated. Let's just take the transport of spent satellites from orbit. This is a colossal ecological problem.

"But that is only one of the initial operations it will perform. The costs of developing outer space—what with the accumulating yield of specific orbital programs and the subsequent travel to the Moon and to the planets—will bring such benefit and such discovery that they will be more than repaid. The creation of new space technologies and new space industries will bring colossal revenues. We already have examples of such tremendous advances and of rapid growth in productivity of labor: the creation of diesels, the creation of reinforced concrete. It was chance, but it provided a tremendous push that made it possible to solve many problems.

"We have to think of our spacecraft as peaceful toilers in space. We shouldn't be afraid of their diversity and development. Here you can't prohibit anything. It is impossible to stop the thoughts of the designer, the engineer, the scientist. We must fight to see that weapons are not placed on these orbital craft. To see that special reflecting mirrors like those in the SDI program aren't installed, that laser beams don't join in combat, scorching all that is living, like the hyperboloid of engineer Garin. If we're successful, the ecology won't be destroyed, nuclear charges won't explode, there won't be the dark aftereffects of war, when, over enormous areas, only the snow blizzard would wield power in the world."

Correspondent: **A snow blizzard [Russian: buran], albeit peaceful and snowy, continued to blow outside when we finally ended the conversation. Business awaited the general designer. The heavy doors of his office closed. And for a long time I had the feeling that, together, we had just completed a difficult first flight aboard the orbital craft and had successfully returned to Earth.**



The "shuttle," secured to the fuselage of the transport aircraft

Air Transport System for Shuttle and Energiya Components

18660023 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 20 Nov 88 p 4

[Article by V. Korchagin, leading designer and technical supervisor of operations; and A. Bruk, section chief and candidate of technical sciences; "Buran Flies to Baykonur"; first paragraph is text of letter written to the newspaper by Yu. Belenkiy, from Odessa]

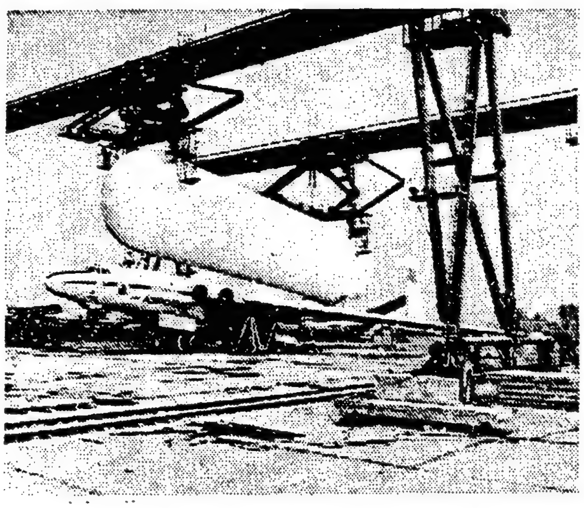
[Text] ***In one of the reports SOTSIALISTICHESKAYA INDUSTRIYA published from Baykonur, I read that large components of the Energiya rocket were delivered to the cosmodrome by a special aircraft. The cargo was attached right on the top of the fuselage. Could you give us a few more details about this unique operation?***

Since the beginning of aviation, it has been thought best to transport cargo inside the aircraft. Attempts have been made to move away from this immutable rule, but people considered them more an oddity.

And then comes 6 January 1982. A remarkable day, one could say without exaggeration, in the history of aviation. A crew consisting of A. Kucherenko, N. Generalov, S. Sokolov, I. Simukhin, V. Padukov, and B. Ayzatulin became the first ever to complete a flight aboard an aircraft loaded with an immense tank. Aviation specialists hadn't seen such a sight in more than a half a century, not since an "aircraft carrier" with several fighters on the fuselage and under the wing—the so-called Wachtmeister Circus—had lifted into the sky. But back then, at least it was clear who was carrying whom. Here, though, was the complete illusion that it wasn't the aircraft that was carrying the tank, but the tank carrying the aircraft. After all, the diameter of the cargo was more than twice that of the aircraft's fuselage. Why were such experiments needed? The fact is that, as early as the 1970s, the question arose of how to deliver large components of the Energiya booster that weighed up to 40 tons and had a diameter of 8 meters, as well as the body of the shuttlecraft Buran, from the manufacturing plants to Baykonur. Various possibilities were examined. Transport by rail was virtually impossible—the size of the cargo was too great. Paved or concrete highways were also unrealistic, and you couldn't lay a special roadbed, or raise electrical power lines, or re-engineer bridges and overpasses. By air? There were no transport aircraft with cargo sections big enough. Even the famous Ruslan, which came about later, couldn't handle something like this. But there was no other way of delivering the cargo—it could only be done by air, on an aircraft with good aerodynamics. And that turned out to be the 201M heavy strategic bomber, which had been developed by the well-known aircraft designer V. Myasishchev. And it was his group that was assigned the job. Some tight deadlines were set.

The simplest approach seemed to be the development of a special container that would sit on the aircraft's back or would altogether replace the fuselage. But it soon became clear that that would require a lot of time and would be expensive. And then the group conceived of a bold idea—put the Energiya sections and Buran right on top of the fuselage. This was so unusual, and it turned so many settled notions upside down, that the idea was well received by only a few optimists in the beginning. Serious arguments flared up. In engineering, however, facts—not emotions—rule. And those facts said it would be worth a try if, of course, the cargoes were enclosed with special fairings.

Studies of aerodynamic interference, aeroelasticity, durability, and stability and the search for the best arrangement of the rocket's sections and the body of the



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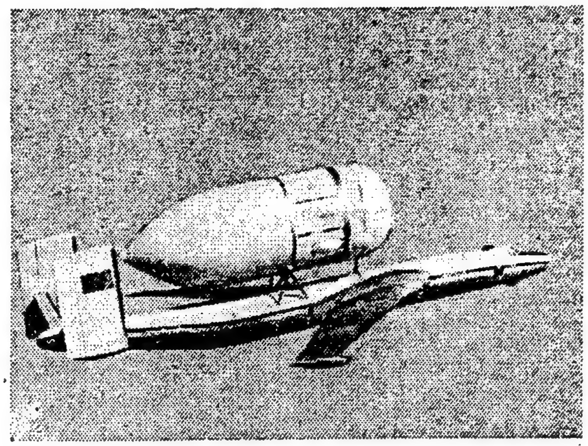


In flight

orbital craft—these were only the beginning. The design of the fuselage of the intercontinental bomber and the control system were changed completely, the wings were reinforced, and engines that were more powerful were mounted. For directional stability, the single-finned vertical tail assembly was replaced with a two-finned assembly with immense end plates. The most powerful of vortices from the interaction of the cargo and the aircraft were able to pass between them. In essence, a new aircraft was created; only the framework for the crew compartment remained unmodified. But more and more new complexities were encountered. The problems mounted, one after the other. For example, the rocket's thin-walled fuel tanks could withstand only axial loads—and that if they were filled under pressure. But they were going to be transported lying on support brackets and, of course, empty. The probability of dangerous self-oscillations of the aircraft and the cargo arose. It was decided to pressurize the tanks beforehand. But if a leak suddenly developed in flight, the aircraft's power supply couldn't maintain the pressure in the rocket tanks. So the tanks had to be sealed with the care given to medical ampules.

This, in turn, gave rise to the problem of continuous monitoring. A system was needed that could distinguish the cause of falling pressure: whether it was because of a temperature drop at high altitudes, or because of a loss of seal.

The group of aircraft designers worked closely with the space technology specialists I. Sadovskiy, A. Tokhunets, V. Burdakov, and A. Lysyakov. They came up with solutions that were out of the ordinary, and they made the most daring of proposals. They worked extremely intensely, with no thought of rest.

The mission was accomplished on time. In the first days of April 1982, a week before the deadline, the new VM-T aircraft delivered an Energiya tank to the cosmodrome. An airlink had been established between the plant and Baykonur, and, for the first time in the world, regular flights began in the transport of constructions of such impressive dimensions.

So, will this unique aircraft merely serve to transport space-program cargoes? That just wouldn't be very thrifty. In our view, it give life to a new area in the development of transport aviation. Different variations in the use of the VM-T in the economy are being studied. It's entirely feasible, for example, to transport in a container, in one trip, an entire 700-square-meter special worker settlement [vakhtovyy poselok]. It might not be that long before "two-story" airplanes are just as routine to us as the Ilyushin and Antonov workhorses. From time to time, life overtakes the most daring schemes—there are plenty of examples in which technical solutions that were unique yesterday are routine today.

Buran Flight Testing, Capabilities Discussed

LD2501213489 Moscow TASS in English 1923 GMT 25 Jan 89

[Text] Moscow January 25 TASS—The head of the flight testing of a Buran Soviet reusable spaceship described as unprecedented the mathematic and full-scale modelling of its flight at test rigs.

Air Lieutenant General Stepan Mikoyan told TASS about some features of the new spacecraft and the work of test pilots and designers before its first orbital flight last November.

The General said that when returning from orbit to Earth, Buran descends and lands without using the engine thrust. This explains considerable difficulties which arose during the spaceship's flight testing.

The flare maneuvering, on which the accuracy of landing on the runway at an estimated speed depends, posed a special problem for experts.

Another problem was path control during the transition from gliding to runway touchdown.

Buran's analog, during its first flights, glided to landing using the engine thrust. Later, pilots controlled the landing manually without using this thrust. The test flights confirmed the correctness of the flight path estimated and modelled at test rigs.

However, the main task was optimising pilotless landing, and the first two orbital flights have been planned to be unmanned.

On the spaceship's flight after the entry into the dense atmosphere, Mikoyan said that the onboard navigation system is used in this trajectory leg. During the re-entry the system determines the coordinates and the velocity vector.

After descending to the so-called plasma-formation zone at an altitude of 35 to 40 kilometers, which blocks radio commands, the spaceship enters the zone of activity of ground-based radio rangefinders in the aerodrome's area.

Using their signals, the onboard equipment accurately locates the spacecraft in space and corrects data in the navigation system.

Onboard computers determine the distance to the aerodrome, the flight altitude and speed, estimate an optimum trajectory, and issue steering commands.

The main task in this fight leg is to bring the spaceship into the zone of activity of landing microwave radio beacons. They emit signals used by onboard computers to steer the spaceship into the estimated glide trajectory.

The onboard equipment's data is displayed in the crew cabin. It will be needed during Buran's future manned flights.

'Energiya' Designer Says Entire System To Become Reusable

LD2801161489 Moscow World Service in English 0310 GMT 28 Jan 89

[From the "Inside Report" program]

[Excerpts] We begin with an account of some details linked to the launching of the world's most powerful booster rocket, "Energiya." [passage omitted recalling the first launch]

The "Energiya" booster is big enough to take payloads of 27 tons to Mars or 100 tons into the near-Earth orbit. More now from the booster's chief designer, Sergey Yershov:

[Begin Yershov recording in Russian with superimposed English translation] With construction underway of the total of three launch pads for the "Energiya" booster, two are already in service. The third one, awaiting additional equipment, is designed for launching Buran shuttles with one flight a year being planned in the near future. [end recording]

The booster's cargo bay is so big that even (?a) combined capacity of such countries as the Soviet Union, the United States, and Japan will be unable to produce the equipment needed to be put in orbit every 6 months. Designers meanwhile continue work to improve the system:

[Begin Yershov recording] The booster's total prelaunch weight is 2,400 tons with future rockets expected to be nearly four times as heavy. "Energiya's" engines are said to be so perfect in design and fuel consumption that they would hardly need any improvement in the near future. The entire system is to become reusable. Strap-on rockets on the booster's body will be used to help at re-entry and soft landing. A parachute system is also provided and cushion supports will be used for landing. The second stage will be fitted with a delta wing for it to land as an aircraft. [end recording]

'Energiya' Designer Cited on Increased Payload, Reusability

LD0302055289 Moscow in English to North America 2300 GMT 2 Feb 89

[Excerpts] [Announcer] The structural features of the Soviet planetary rocket Energiya are such that the payload it is capable of orbiting can be increased to 200 tons. This was stated in a lecture in Moscow by Dr Boris Gubanov, the chief designer of the Energiya space rocket system. More about this from our science correspondent Boris Belitskiy:

[Belitskiy] Dr Gubanov was speaking at the 13th Korolev Readings, an annual series of lectures on space research commemorating Sergey Korolev and other space pioneers. The lectures were presented here in Moscow at the end of last month. The main topic of discussion this year were, naturally, reusable spacecraft. [passage omitted on U.S., West European, and Japanese projects of this type; November maiden flight of Buran]

But Soviet experts are also working on the Energiya rocket itself to make it reusable, as Dr Guvanov put it. Dr Gubanov said that in future it is proposed to equip

the units of the Energiya rocket's first stage with salvaging facilities. In other words, with parachutes, soft-landing thrusters, and landing shock absorbers. After the separation of the first stage units these will assure the guided flight of the units and their soft landing in the required area.

It is also proposed to consider the possibility of making the rocket's second stage likewise reusable by fitting it with wings. This would enable the second stage to return to the launch site and land there on a runway.

In short, the propsect described by Dr Gubanov was one of reusable winged aerospace systems. I would put it this way, Gubanov said, we are now on the threshold of a transition to space plane systems. In this respect the design of the present system represents a mating of rocket and aircraft technology. As for the shuttle Buran, it is not the ultimate goal or destination of our program, it is more correct to describe it as one of the points in our extensive program of developing aerospace systems.

Chase Plane Pilot Tolboyev Describes 'Buran' Landing

18660072 Moscow KRASNAYA ZVEZDA in Russian 25 Nov 88 p 1

[Article by A. Andryushkov, Colonel (interviewer)]

[Excerpt] Before the reusable spaceship "Buran" lowered its landing gear and touched the ground, a MIG-25 fighter-interceptor met the spacecraft in the air. This airplane was flown by test-pilot Magomed Omarovich Tolboyev. A conversation between Tolboyev and our correspondent is published here.

"Comrades from the contingent of test-pilots which Igor Petrovich Volk heads and I were together at Baykonur from April on [said M. Tolboyev]. We rehearsed programs for prelanding maneuvers, runway approaches and landings, using laboratory airplanes of the TU-154, MIG-25 and SU-7 types. Interception of the 'Buran' and escorting the ship to a landing were simulated. We were trained how to conduct television transmission to the Flight Control Center in the process.

"All kinds of unexpected events could occur during the orbital flight of the 'Buran,' such as damage to parts of the airplane in the dense layers of the atmosphere, control failure, and failure of landing-gear struts to extend. Up-to-date and reliable information must be available on the ground. A laboratory airplane based on the serially-produced MiG-25 fighter-interceptor was developed for the purpose of accomplishing this task. This aircraft is called an airplane for optical and television observation. I was given the mission of intercepting the spaceship.

"Whereas the 'Buran' flies at a speed as high as 3,000 kilometers per hour at an altitude of 20,000 meters, its speed at 10,000 meters is about 800 kilometers per hour. This involves very sharp braking. A MiG-25 can intercept the spaceship in the stratosphere, but it is almost impossible to escort the ship with such braking. One is sure to shoot ahead of it. How to solve this problem?

"We rehearsed a version of meeting the 'Buran' at medium and high altitudes in the zones where the spaceship was to be expected with the direction from which it could arrive from space was known in advance.

"Interception began at the moment when we turned into a course on which the 'Buran' would be encountered heading in the opposite direction.

"When interception appeared to have been accomplished, the 'Buran' set us an operational problem: it hooked so sharply that it was as though the spaceship felt it was being attacked. Everyone realized that at this moment the ship had selected the most optimal precalculated point for a landing approach and had confidently executed an intricate maneuver. But for me it was unexpected. It had not even been rehearsed during training.

"At that altitude, wind velocity was as high as 200 kilometers an hour. Our MIG-25 Was thoroughly buffeted about. To approach the spaceship in such conditions was somewhat hazardous.

"The 'Buran' shot past me and I found myself behind it. There wasn't enough time to turn after it, because the radius of such a maneuver would be great. I then threw the MiG-25 into a spin, twisting it around the axis. After half a turn, I set the controls to pull out of the spin. I found myself in the rear half sphere of the 'Buran.' There was no other way of overtaking it."

"I am sure that KRASNAYA ZVEZDA's readers will be interested not only in your flight to meet the 'Buran' but also in you as a person."

"I am 37 years old. I was born in Dagestan, in the village of Sogratl. I am an Avar by nationality.

"By order of the rayon military commissariat, I enrolled in the Yeysk Higher Military Aviation School for Pilots imeni Komarov after completing the 10th grade in school. I served in combat units, first in the Odessa Military District and subsequently in the Soviet Forces Group in Germany. I have flown fighter aircraft of the Su and MiG makes.

"In 1980, I enrolled simultaneously in a school for test-pilots and the freshman class of the Moscow Aviation Institute imeni Ordzhonikidze. I have completed a course of general space training at the Cosmonaut Training Center imeni Gagarin. I am currently working as a test-pilot at the Flight Research Institute of the USSR Ministry of Aviation Industry. I have mastered 37 types of airplanes and helicopters."

(A photograph of M. O. Tolboyev is given.)

Designers' Commentary on Buran Flight Control System

18660021 Moscow PRAVDA in Russian 6 Dec 88 p 3

[Article by G. Gromov, doctor of technical sciences, General Designer of electronic air traffic control, navigation and landing systems, and A. Reutov, corresponding member, USSR Academy of Sciences: "Radio Path From Space"]

[Text] The automated landing of the "Buran" air-spacecraft left a lasting impression on those who observed it visually from the joint command-control site located at Baykonur.

Whereas the launching of the "Energiya" rocket-space transport system with the "Buran" ship was accompanied by flames and the thunder of very powerful engines, the landing of the orbital ship transpired in total silence, which at the last moment was disrupted only by an optical-television observation aircraft. Everyone had the sensation that the "Buran," in making its automated landing, possessed its own intellect. The phrase "automated landing" consists of two words, but what an enormous volume of work stands behind them, and most importantly, the carefully coordinated interaction of a large number of complexes, systems, mechanisms, and structures, and, to be sure, the cooperation of different groups of workers.

The complex of electronic systems and apparatus positioned about the several thousands of square kilometers in the vicinity of the airport had the task of "picking up" the approaching air-spacecraft; of carrying out constant monitoring of air-traffic situation and the motion of "Buran" along the programmed trajectory and the execution of the prelanding maneuver for dissipation of kinetic energy; of putting the vehicle precisely into the computed landing trajectory (glidepath); and of ensuring the touchdown up through its final landing run.

The electronic systems developed for this purpose by the radio communications industry were integrated into a unified navigation, traffic control and landing system, which was assigned the name "Vympel" [air message drop]. It includes the instrumental and electronic systems that make up the ground and on-board equipment. In order to ensure the highest functional reliability of the "Vympel" system, the designers constructed it in such a way that "Buran" was guaranteed the necessary information at any time, no matter what the roll or pitch angle. A number of new radar stations, radio beacons, pieces of on-board equipment, computers and data display systems were developed for monitoring the "Buran" flight as well as all air-traffic conditions in the region of its flight and control. The appearance of any unauthorized airborne object in the zone of "Buran" descent must be detected. If it would hinder the air-spacecraft from coming in for a landing, it would be directed away from the monitoring zone.

A highly important task was to ensure landing regardless of the weather or time of day. This is achieved by the use of radio signals which are least subject to attenuation during rain, snow or fog. In developing these means, particlar attention was devoted to their resistance to interference.

The 'Vympel' complex consists of three data-control systems.

The first is a radar system which creates a zone "covered" by a continuous radar field in the vicinity of the airport with a radius of up to 500 km from the landing strip. This field is created by ground radar stations that make it possible to detect aircraft from signals reflected off them as well as signals transmitted by on-board transponder-repeaters. The "Buran" transponder, responding to the radar stations in a special code, makes possible reliable detection and identification of the craft approaching the landing airport.

The system includes long-range surveillance radars with a range of up to 450 km, an airport surveillance radar with a range of up to 200 km, and a three-coordinate landing radar with a range of up to 40 km. The aircraft transponder, in responding to their interrogations, emits response signals in which data on flight altitude, tail number, and other motion parameters are coded. The computer complex also compares the actual and computed trajectories and, if necessary, can issue correction commands. The principles developed during "Buran" tests are finding their application in the improvement of modern air traffic control systems for different types of airplanes and helicopters, which is an important economic contribution of the "Vympel."

However, these data alone are inadequate for the precise landing of an air-spacecraft on a strip 80 m wide. For that reason, the "Vympel" complex forms the main, precise radio navigation field, which enables "Buran" itself, with its control system, in an automatic mode, to determine its position in space and time. An individual does this on the ground relative to some known landmark; a ship at sea gets its bearings from light beacons on the shore. Radio beacon-relay stations, located in the vicinity of the landing airport at six points with precisely known coordinates, were constructed for the "Buran."

The on-board equipment of the radio navigation rangefinder system consists of four identical measurement devices that back each other up. About 60 times per second, each of these simultaneously determines the range to three relay systems selected by the on-board computer.

The final part of the flight is supported by the third data-control system of the "Vympel" complex: a microwave electronic all-weather automated landing system consisting of three radio beacons: elevation, azimuth and range relay systems, set in each of the landing directions. These beacons form a singular "radio path" in space along the longitudinal line of the landing strip, a path that conforms precisely to the stipulated descent line.

The on-board equipment of the landing system receives the signals, processes them, and sends highly precise information on the ship's coordinates relative to the ground radio beacons to the on-board computer complex to generate control commands.

It was precisely this electronic landing system, jointly with the on- board automatic control system complex, that, during the test flight, placed the craft on the center line of the landing strip with a deviation of only 3.5 meters, and enabled a landing run and stop within 80 centimeters of the center line (for the front wheel).

The "Vympel" electronic complex demonstrated a high efficiency during the test flight of 15 November. After entry of the craft into the radar field zone, the data from the radars were automatically relayed to the computerized trajectory monitoring complex of the command-control point [KPD] for use by the regional command-control group and to the computer complex of the air traffic control point. A screen displayed information on the current position of the orbital craft in the form of a bright dot accompanied by a log indicating the altitude and tendency of change, course, and airspeed. There are several display scales, depending on the stage of maneuvering, approach for landing, and landing. The display screens also show the computed landing trajectories and the landing strip.

At the same time, from the digital computer complex information is relayed for display at similar operator positions at the main command-control group at the Flight Control Center, located near Moscow.

In general the "Vympel" complex is constructed on principles guaranteeing the reliability and accuracy of the automated landing of the craft. This is attained by double and triple back-up of ground and on-board systems, with thorough, built-in automatic monitoring and overlap of coverage by electronic navigation, landing and radar systems operating in different wavelength ranges. The on-board and ground apparatus was designed on the basis of the latest scientific-engineering advances, promising microminiaturization technologies, programmed data processing methods, and the use of microcomputers and surface complexes with a distributed structure on the basis of minicomputers.

The "Vympel" complex was debugged simultaneously at the "Buran" landing airport, under actual conditions, and at analogous complexes. One of these complexes was set up at the flight research center of the All- Union Scientific Research Institute of Radio Apparatus near Leningrad. Here the entire cycle of flight tests was carried out for the controlling on-board complex, jointly with the ground and on-board electronic equipment systems. In the course of the tests, use was made of "Buran" flight simulators and specially developed flying laboratories based on the TU-154 and TU-134 aircraft.

The development of such electronic apparatus enabling the world's first automated landing of an air-spacecraft, was a new, major stage in the development of Soviet electronics.

On 15 November 1988, together with the outstanding advances in Soviet rocket and aircraft construction, the great capabilities of our radio communications industry, which has developed a fundamentally new data-and-control complex, were demonstrated.

The "Buran" landing lasted several minutes, but what enormous work of scientists, engineers, technicians, workers and test pilots stands behind them. This work, expressed in the jeweler's precision of the operation of all systems of the landing complex, demonstrated the high potential for enabling all-weather and, later, automated landings of aircraft of various classes. Work experience accumulated in the course of development of the "Vympel" complex is helping in the development of a mass-produced, highly precise electronic system for the landing of aircraft.

Equally important is the birth of new organizational forms of work of large teams of scientists, engineers, workers and director-organizers of enterprises, ministries and departments without departmental bureaucratic barriers. The new work methods have, in a short period of time, made it possible to solve complex scientific-and-technical and organizational problems and to identify and produce optimal variants.

As a result, a single, well-integrated body of workers has been organized that is capable of developing and introducing large-scale, scientifically sophisticated electronic complexes and of marshalling in a short period of time their collective intellectual potential for the solution of the new problems facing science.

Development,Testing Procedures for Buran Shuttle

18660054 Moscow PRAVDA in Russian 2 Jan 89 p 4

[Article by PRAVDA correspondent Andrey Tarasov; "The Pilot Project"; subtitled "Energiya-Buran: The Event of the Space Year"; first paragraph is opening sidebar in source]

[Text] ***There's a lot right now that I'd like to recall, comprehend, explain. Certain moments I'd like to relive—but more slowly, as in slow motion. But, all in all, a simple frame of the events has forced its way in. In the airplane that's leaving Baykonur, a tired fellow, one who's breathing as if he'd just finished a long run, takes a seat near the***

journalists and asks: "Well, guys, what is this thing? I've been working in this program for ten years, and I haven't seen it once. What is it, tell me?" So I'll make an attempt here to tell you about it. And at the same time, about the people who, for ten years or more, have been working to transform this difficult project into reality, often without the opportunity to take a look at the result of their labor in all its flying beauty, because they're working back in the bunker or in the plant shop.

So let's be frank. If the word "sputnik" has become ours forever and everywhere, and you can no longer substitute it for just any kind of "satellite," then the transoceanic word "shuttle" has been planted just as firmly in the world lexicon (albeit with a nuance that, in the final analysis, it's also a sputnik). "What about our shuttle—will it fly soon?" "Their sputnik" and "our shuttle"—such is the dialectic of technical development, of movement along different paths toward the same target. One arrives first, the other arrives after him. And some things they can solve only together. To one, this goal seems paramount at the present; to the other, it becomes paramount later—other concerns overshadow it now. We both have long-standing space programs, which also invoke legitimate feelings of pride, but require immense resources...

And maybe the fact is that for too long, until only recently, the word "Buran" (and with it, "our 'chelnok' [shuttle]") was under a ban, and only specialists with the highest clearance uttered, it in a whisper, looking over their shoulder. And it was also suggested to us—simple, trusting people—that nothing of the sort was taking place in our country and that nobody was thinking a thought about it. "We don't need it," was heard at the levels of glasnost. And then, all of a sudden, it turned out that we do need it and we already have it.

This has to do with the fact that somewhere national programs that excite thd public, infusing it at the same time with a feeling of self-respect, are announced for general information and discussion.

So okay, let's assume that this priority was given to us. So if it was given to us... then hanging on the wall in a row with other photographs in the office of Gleb Yevgenyevich Lozino-Lozinskiy is a photograph of a small aircraft.

An airplane as airplanes go—compact, attractive, the folding wing is interesting, a wing that gives some dash to the appearance. But that's not all. This is the same prototype of an air-space craft that has long been the cause, to this day, of many rumors and much talk. What caused them? Yes, an airplane appeared that was "jettisoned" from its powerful "colleague", which had climbed to 9,000-10,000 meters. Landing it was the well-known test pilot, A. Fastovets. At first, he just took it down, for a landing. After that there was the dream that aviators—flyers and designers—had, in fact, never hidden, not since man had entered into space: to take off for space as an airplane would, and to return as an airplane would. To go from the airy ocean into the ocean of space. After all, it's so natural—just an extension of flight.

The next step was to go into space, into a satellite orbit. But it was interrupted by a resolution of the then-minister of defense regarding the plan for subsequent work. Word for word, it goes like this: "Again some kind of fantasy. But now is the time to begin getting down to business." Marshal Grechko is no longer alive, so it's hard to discuss it; but the aviation community is convinced that if it hadn't been for that, our aerospace airplane would have reached orbit long ago. And the offensive phrase "our 'shuttle'" would not have grated on our ears.

Recalling this with understandable bitterness are Lozino-Lozinskiy—the chief designer of the "prototype" and now the chief designer and general director at the scientific production association where Buran was created—and his closest colleagues, the "little old men" of the aerospace project who had held on to their cherished dream until the next round.

I'd prefer not to believe that it was simply the American program that forced us to suddenly think about starting on this expensive and important round. There are reasons that are more personal and more serious; in general, of course, that same dialectic of the technical development of mankind seems to me to be irrefutable. "We need to sail the seas"—those landlubbers who thought that they had everything on land and that the sea was only dampness and rolling were wrong. But about that a little later. Facts remain facts. The work that was interrupted for ten years has arisen on the basis of the new rocket-and-space technology. Such a carrier vehicle has shown itself to be more reliable and more versatile. So in a single task there has been combined the experience of the aviation and space programs: immense allied departments, firms, scientific research institutes, and a whole pleiad of industry chief designers.

"What we are calling the 'glider of the orbital craft' [planer orbitalnogo korablya] is, of course, not a direct extension of what was started, but a totally different stage, a completely new development at today's design and engineering levels, which have absorbed recent achievements in cybernetics, automation, materials science, and a multitude of allied sciences..."

At almost seventy-nine years of age, Gleb Yevgenyevich Lozino-Lozinskiy—Hero of Socialist Labor, Lenin Prize winner, and a State Prize more than once—has an athlete's appearance and dresses with a faultless elegance, setting a stylistic tone for all the scientific and technical personnel. Among the traits of the chief designer "out in the corridor" are these: he can do an enviably enormous amount of work, wearing out the younger men in the process; he is extremely meticulous in examining the different variations of a proposal; he

can grasp the essentials of a proposal, down to the finest points; he is capable of working at the rank-and-file level (an especially valuable quality in superiors of such rank)...He is observant and can see through an individual. He is infinitely erudite and profound in posing and comprehending problems (the good, old technical school that the quick-figuring youngsters don't have). At the same time, he's not amenable to changing his mind, and he considers his decisions incontrovertible (again, the good, old school). He is ascetic (the old school), which can have a negative effect on "hacking out" rewards and privileges for the successful testing of Buran—he feels that the result itself is the best reward for its developers...

It's easy to say: "glider" (although it's a glider of an orbital craft). Something with sweeping wings, soaring, affected by the smallest stream of air, immediately comes to mind. But you don't want something comparable in mass and load factors to the the TU-154; rather, you want something with "stumps" rather than wings, because in one leg of the flight you want it to be more or less a smooth-bodied rocket, whereas in another it needs to be a true airplane. For that reason, something in-between is chosen. Packed with guidance electronics, the craft—frozen in the vacuum of space to -130 degrees, and then several minutes later heated by the plasma cloud of the thickening atmosphere to +1500 degrees, first in the pitch black emptiness, then in the hurricane gusts and iron-like blows of the wind from the side and head-on, shattered along the "cobblestone" and bouncing around in the air pockets—slips down from a 100-meter steep climb, using a preset program and the guidance of radio beacons to locate its own concrete runway on the immense globe of the Earth. It must descend, touch down, make its landing run, and come to rest, where designated...

Yes, as an orbital craft, it could even be a pyramid, or a cube. In weightlessness, in theory, it's makes no difference. But as an airplane, your fate, as they say, you can't escape, and you can't get around aerodynamics.

How do you overcome a whole cycle of errors and blunders and the investigation of variations in order to arrive at the truth faultlessly? After all, lifting "Burans" into space for gradual development like ordinary airplanes (higher, farther, and faster each time) is unrealistic. In essence, you have to throw into the water a first-class swimmer who has learned how to swim on land. A bit of a problem?

Nonetheless, I am on a "Buran" that has completed about 1,400 preliminary flights. And I can see the "internal organs" that fill its fuselage. Imagine the racks of a baggage compartment of a passenger airbus, jammed not with suitcases, but with electronics cabinets in serpentine cable jungles.

The PRSO [polnorazmernyy stend oborudovaniya] is the full-scale equipment test stand, which duplicates in a huge hangar the contours of the "bird" with all its innards. The cabin, the fuselage, the wings, the tail fin—but without the outer shell. Walking and crawling, as you make your way from unit to unit, you can retrace the path of, say, the signal picked up by the receiver from the radio beacon, intentionally miscalculated in the on-board computers (four cabinets about the size of a tractor battery, backing each other up), processed in a dozen boxes, fed to the hydraulic control drives, and, finally, pulling up or down the aileron flap and right or left the tail rudder bar. About a regulator that converts a tiny pulse into a powerful exertion of thrust, I hear someone say: "It's made in such a way that you could hook up a train to a housefly through it and the fly could pull it." Such is the quality of the unique components of the machine.

Once, Gleb Yevgenyevich arrived for a "flight" and heard: do the rudder and the air brake really grind so in actual conditions? And the noise, it's true, was horrifying. At the peak of testing, during such test flights, this place was crowded with some five-hundred people, who were responsible for their own instruments. Everything was examined: every unit separately, and every unit in terms of its electromagnetic compatibility. It started with a mass of problems. The instruments in flight would simply run all over the place and the needles would gyrate wildly...

Buran would fall **here** so as not to fall **up there.** Using this formula, the chief of the experimental department, V. Zimenkov, determined the essentials of operation by evaluating the on-board software in its interaction with actual on-board systems. Nothing was written to the computer's memory, not one instrument or unit flew, without first being tested and hooked up to the PRSO. Manual and automatic modes, horizontal flight tests of the simulator, and, finally, the first two-revolution orbital flight. That's all been done now. Now everything starts from the beginning—for the standard flight based on the entire program, in which the automatic equipment and the pilot will be interacting from an altitude of 100 km to 0...

The people who are around us didn't come here for something that was ready-made. Some came from the old haunts of Tupolev or Mikoyan; others straight from VUZes: all were captivated by the new task that was unlike any other. And if only it had been simply a scientific task! There used to be a tent standing here, before there was ever a hangar with walls and a roof, and the equipment was beginning to be brought in and assembled. Lodging had to be built for people. Furnaces, mattresses, televisions, fur coats had to be supplied. The people equipped and designed their ground-based Buran and celebrated its first "flight" with as much emotion as a real launch.

And how did they prevent overheating? Not themselves—they were fine. But the entire multi-ton electronic filling, which becomes a veritable oven when it's

in operation, but at the same time doesn't allow its microprocessors, transistors, diodes, and triodes to be in any thermal discomfort. Their favorite room temperature is 20 degrees.

"And if there's no cooling?" I ask, just in case. "How long would it last?"

"It would burn up in a half an hour," V. Novikov, the chief designer of of the temperature-regulation and life-support systems, says matter-of-factly.

Of course, it wouldn't burn up in flames, but electrically; but it's no easier to prevent that. There are unplanned situations that occur suddenly, when external and internal causes cross, and five or six minutes is all it takes for the equipment to be in crisis. Then you have an uncontrollable "Flying Dutchman" rushing along through the airy ocean to God knows where.

For that reason, there's another "Buran" in still another room—but this time it's like an x-ray. Or maybe a museum skeleton of a dinosaur: massive ribs—pipelines wrapped in white insulation and filled with circulating water and a cooling agent. The water is "holy"—distilled, and containing silver ions. It works excellently and is even a better cooling agent than liquid gases. But if you take 400 liters aboard the first time, how much do you need later?

Here, it turns out, it is produced in a replenishing supply. When the regular electrical system, which is based on hydrogen-oxygen batteries, begins working, it develops a great deal of energy, and a great deal of heat is given off, and a great deal of circulating water is produced. In orbit, space itself helps to cool things—when the cargo section is open, radiation-type heat-exchangers inside the doors come in contact with space.

"Can this system be compared with the Salyut-Mir system?"

"Compare them yourself: electrical-power consumption aboard Mir is 11 kilowatts; aboard Buran it's 40. The heat increases accordingly. It's true, for the first flight, 17 kilowatts was enough..."

That means, the main stress is still ahead. But on Earth, it is already being applied to the craft's systems. Here are these green "bags" everywhere inside the tubular "skeleton"—they are simulators of absolutely every instrument of the on-board complex. Every firm that creates an instrument must also provide its thermal twin, which can reproduce all phases of the flight. Each has its own personal heat plate [termoplata], a tightly pressed, flat tube with corrugations. This is the heat-yield feature. For re-creating the external conditions that arise, planned and unplanned, when the airplane is cast first into heat and then into cold, there is an entire refrigerator plant behind the walls. Alas, cold is free only in space—if only we could somehow learn to use it profitably.

When you see one test stand after another, with all the on-board gear, you can only be surprised that it can all fit into one vehicle. There's enough equipment for ten machines. Here it is, though, all together, all pressed together, with enough room left for a thirty-ton cargo-...Now it's time to think a little about seeing to it that all this isn't lost or broken apart by overloads, beginning with the body itself...

"And how much time would it take you to smash this thing completely? Could you do it in twenty-four hours?"

"Twenty-four hours?" V. Kostsov, a representative of the renowned guard of structural engineers, was truly surprised. "What do you mean, twenty-four hours! We could smash it to pieces in seconds! But nobody'll ever be told to to do that..."

The task at hand actually combines enormous force and a jeweler's precision: to determine the ultimate strength and to identify the breaking point—without breaking the metal. In the chamber for static testing, "Buran" is still a rust-colored metal, uncoated—it's like Gulliver in the web of Lilliputian wires. Wires are stretched to the walls and ceiling. However, apply full force, and these 256 cables, which are equipped with hydraulic cylinders with a pull of from tens to hundreds of tons, as well as with infrared heating of up to thousands of degrees, could actually leave the craft in shreds.

Kostsov himself—also a hale, solid, strong man, not unlike a veteran boatswain in his movement along the ladders and decking of the different levels of the hangar—remembers a time when the loads were applied with nothing more than bags of shot. That's why he's so enthusiastic when he shows us the computerized complex for control, monitoring, and data processing; the automatic equipment for controlling the load-application cylinders; the powerful marine pumps that make the basement of the static testing chamber look like the engine room of a ship...Strain gauges and strain dynamometers, tiny instruments; a web-like latticework, made of the finest wire, which sounds a signal indicating the cable tension as well as the metal stress in real time through computer processing...A reinforced floor, with slabs one-and-a-half meters thick and capable of sustaining a load of 30 ton-force at any spot...Reinforced walls...A feature of this chamber that distinguishes it from ordinary airplane test chambers is that it makes possible the application not only of lateral load factors, but also "x" load factors. That is, it reproduces the moment of insertion, or, to put it quite simply, it "pulls on the tail," like the inertial forces during vertical climb. What would such forces equal in terms of weight? A braking parachute, for example, creates a force of 65 tons. It's entirely possible to rip off the tail if you don't calculate properly. And each such "load" segment must be tested for the provision of 100 flights—the reusability service life.

And how, specifically, do the load-applying devices hook onto the metal of the aircraft? Well, here we have sacred simplicity. Ordinary canvas straps, primer, and adhesive. They're glued and then you pull, with forty-four straps for each drive...

"It's too bad, you're not going to hear it now at night, when the statics are working and outside noises don't interfere. That's when you can hear the crackling—the structure is "alive"...And the levers clicking from time to time—it's music that claws at the soul..."

Now how about if we hang upside down for a little while. Just a little while—maybe an hour or so. And right after that, hop on a bicycle, say. Only, don't ride along a concrete superhighway, but along a rugged, winding road...It's difficult to find a comparison for the state in which a pilot finds himself when he's guiding an aircraft in for a landing after a week of weightlessness. But it's not hard to imagine how professional that pilot must be. Igor Volk, the test pilot who went into space briefly aboard Salyut-7 in 1984, has long been head of the group of pilots in the Buran program. In the Buran circles, the group is good naturedly called the "Volk pack" [Ed. Note: pun based on the Russian word for "wolf": volk].

With hair as red as a launch flame, chiseled features, and a steely, unwinking gaze, he is all thought as he ponders the problems of the coming stage, when the pilots take their places in the cabin of Buran. And the problems are many—it wasn't for nothing that Lozino-Lozinskiy himself said that piloted flight will, both in number and in complexity, more than double the problems. And the most difficult problem will be interfacing the functions of the automatic equipment and man. This is urgent at a time when the technology of machines is evolving not only in the air and in space. The nuclear power plant, the railroad, the ocean-going vessel, any automated plant, urban "life-support" systems, the ecology—critical facets of the problem are everywhere. Working here, unlike anywhere else, are fractions of seconds, superspeeds and overloads that leave not the slightest moment for misunderstanding or tardy questions.

We admit honestly that the recent failures of the automatic equipment during two consecutive landings of crews from orbit, as well as the fate of the Phobos-1, which is now lost forever, are forcing us—no, of course, not to have misgivings—but at least to approach the debate about which is superior—automatic equipment or man—with special care. This debate, it seems to me, is still in full swing. And it will probably have a long future, depending on the level of its components. But we wouldn't want to end the debate in a critical situation with something that was too much of an object lesson—it would be far better to resolve it by means of real scientific study before reaching that point.

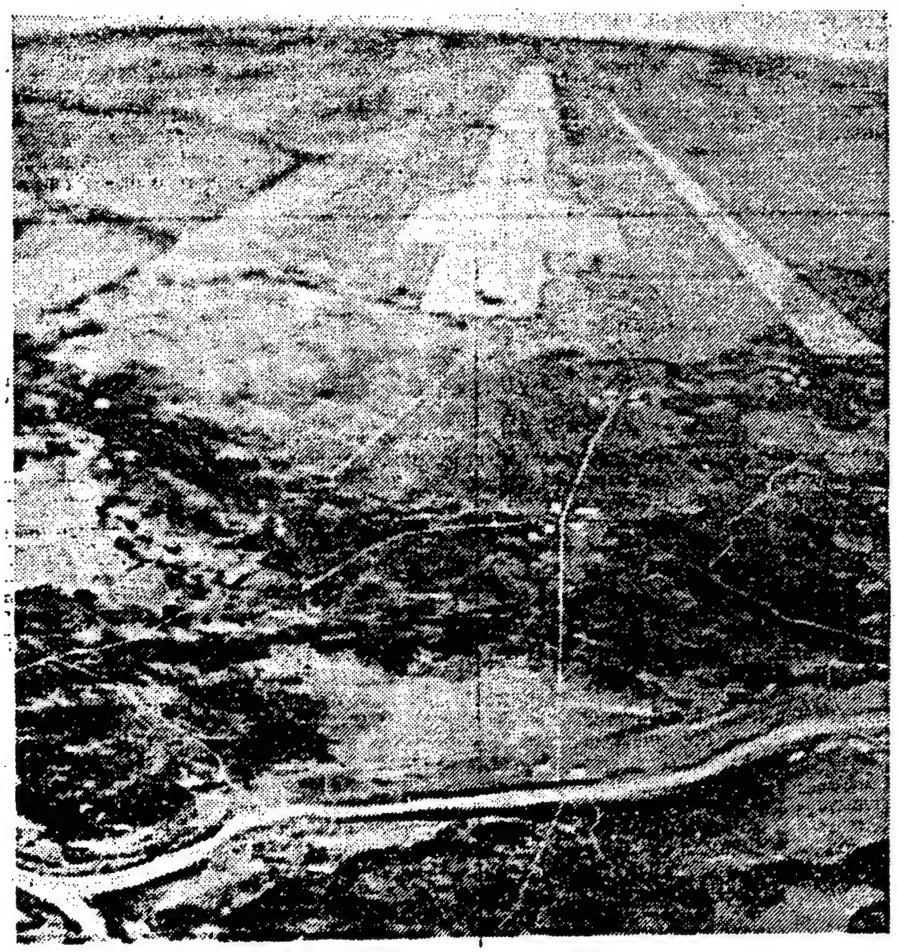
I even heard someone shout for joy on the runway, near Buran, after it landed: "Now it doesn't even need any pilots!" Of course, one would have to be a grand optimist to come to that fatal, as it were, conclusion after merely the initial, far-from-full-scale tests. Second, I'm curious about whether that same individual, even with the most advanced automatic equipment and a thousand guarantees, would trust his own fate to a pilotless machine; would he fly into space aboard it as a passenger? Personally, I wouldn't, not for the world. For even if a pilot didn't have to lift a finger to anything, his being ready to take control would still be the primary guarantee of reliability for anything that's flying.

That doesn't mean, of course, that the pilots stood on the side during the pilotless testing. After all, someone has to take the machine up into the air and get it to the automated landing area for putting the finishing touches on all the systems and, in general, for "trying its wings." The Americans released their shuttle from a Boeing aircraft; we built our Buran analog with four engines—so it could fly in the atmosphere. Igor Volk and Rimantas Stankyavichyus were the first crew to take it up. That was on 10 November 1985.

The pilots accustomed themselves to the steep trajectory and the absence of manual control in the TU-134 and TU-154 trainer aircraft, the steep diving MIG, and in the simulator that I saw next to the equipment test stand in the test chamber. The creators of the simulator applied a wealth of creativity, talent, and computer mathematics so that, after comparing the simulator with real flight, the pilot would say, "It's close to real flight." But down here the flyer has his hands full: in the sky, he would probably never ever see the kinds of emergency situations he sees in the simulator. "We've had everything here," recalls ground "trainer" Yu. Borisov. "At first, they would 'crash,' the situations we set up were so tough. Then they gradually began to master it, got some experience and some confidence, and would land the plane with just one wing, or one wheel, or various other problems." In a word, about 150 such problems can be "ordered up."

Of course, it would be nice to have such simulators used more often for all our aviation—for now, they say, we're behind with them. But it's not just the Buran pilots. Volk and Stankyavichyus have spent 60 hours in that cabin. In all, pilots have spent some 3,200 hours mastering the simulator. Inside is "Buran's" cabin. There are two positions with high-backed ejection seats and an instrument panel with three television screens. There are television cameras trained on the pilots from in front and from behind. The floor is perforated—beneath it, on the first level, is the orbital compartment [orbitalnyy otsek], a small crew's quarters that is free of instrumentation. Behind is a viewport looking into the cargo section. It's practically a small hangar, and you could fit almost the entire "Mir" station in it. Right now, the section holds the fuel tanks of the engine-powered simulator. And so everything is in its place.

Having been admitted here after signing the visitors' log (each must write who he is, why he's there, and how much time he's spent on board), I am trying to get an



Landing strip on television screen of pilot training test stand

idea of the arrangements for the testing workdays and days off. The words "test team" recur several times. Then it turns out that it is about 800 individuals from a great many plants of various ministries. "Here's the man who holds the record for 'not leaving work' the longest," says O. Dolgikh, the head of the flight-test facility, as he points to his colleague N. Ayloyan. "Seven days in the shop..."

It's quiet around "Buran" now, but at one time in the past an uninterrupted cycle of debugging and testing of the systems went on for months. There was almost a year between the first time it taxied out and the first time it took off. Then almost a thousand problems had to be worked through. Everything down to the finest detail: if you're connecting up a plug and socket and you're not wearing a braclet that removes static electricity, you could burn up a microcircuit. It was another year before the automatic equipment for landing from an altitude of four kilometers was completely hooked up. That was on the eighth flight, in December of 1986. Those who were present could not believe that Volk and Stankyavichyus had resisted the temptation to take the controls manually. The simulator landed so cleanly and accurately on the runway. There were flyers who had landed directly in automatic mode, without a smooth transition. It was also no big thing, they made it.

There is a color screen, with the videocassette purring. Clear blue sky, green grass. "Buran" is above the airport, accompanied by an Su-17. The take-off, the turn, the landing. Down the ladder, in the powder-blue overalls, come Anatoliy Levchenko and Aleksandr Shchukin. Handsome, intelligent, strong; they have finished their work. They're tossed up in the air convivially by the solid hands of their comrades and given bouquets of flowers. Lozino-Lozinskiy listens keenly to the report on the flight, and Volk, who has just left the cockpit of the Su-17, squints his eyes affably. "A big step forward was made today," says the chief designer. It's both interesting and painful to look back. No one among those people knew at the time that we would lose both those superb crewmembers about two years later. An illness would take Anatoliy, and a mishap in the air would take Sasha. In a different aircraft, on a different mission. A stern reminder. There are no cloudless skies in this profession. But you have to keep flying—and young men have arrived in the detachment for that purpose, the best the test guard can provide.

What makes these tests different is the colossal saturation of the monitoring and data complex. Even the airborne "Buran", via telemetry, provides the airport flight control center with an abundance of information on all its systems, units, and modes during its flight. For an aircraft, this is new. But, one should hope, it holds promise in future tests of various types of craft. And why shouldn't the ground-based traffic control service have before its eyes this data on a passenger or transport aircraft in an ordinary flight?

Using computers alters not only the technology of design, but also the psychology of the designer, from chief designer on down. One instigator of this process, Deputy General Director A. Nikitin, explains: "This is our scourge—coordinating the paperwork, getting the permits and permissions. Take a look at the timid figure of the engineer or the designer—and think how many hours and days he loses in the doorways of his superiors, waiting for a signature. And if there's a problematic situation, he may be waiting for months. But what if it were this way: the document is put into the computer system and it goes to the chief's office. It's electronic mail. But with a restriction—a three-day cycle is prescribed. That is, the document can stay only three days in the machine of any given addressee. Silence is taken to be concurrence, and it goes to the general designer for his signature..."

This only one element of a process control system that is being introduced (not without a fight, we must honestly say), but it is farily indicative. "Buran", as a pilot project—that is, a project on a completely new level, with new features—has cut into the organizational, even the economic, patriarchy. What specialists of all levels and types feel it has shown more clearly than anything else is the impossibility of working in the old way. So much so that it can well be thought of as a harbinger of the organizational and technological revolution to come.

"In any given production area, CADS managers stay on with us an average of no more than five years," M. Osin, the head of the CADS department, says, laughing bitterly and bravely through his black beard. "And they depart with a great deal of noise. I've held on for 12 years already. There's hope."

Yes, automation of design is serious business—it's more than simply figuring out thousands of variations and models on a computer instead of ten in your head; it's more than rapidly drawing something out with a graph plotter instead of a pencil. You see this especially well in the creation of the heat shield for "Buran".

"Why in one place do they write that there are 38 thousand tiles, in another that there are 37 and a half, and in yet another that there are 36?" passionately and even angrily asked the director of the plant that had built Buran. I thought he was about to curse me because of the poorly informed press, but I was mistaken. "Because we ourselves don't know! And don't need to know! Drawingless—or rather, paperless—production doesn't need it."

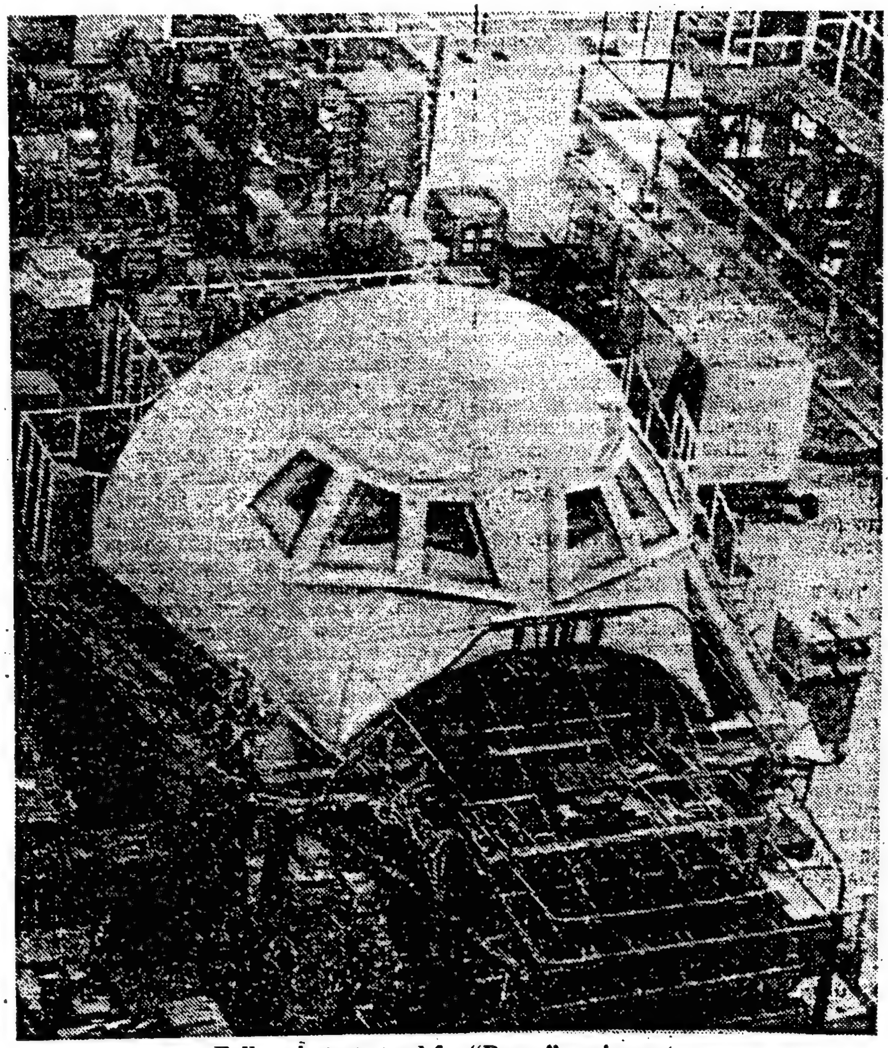
They say that when they first started talking about putting out forty thousand tiles in the drawingless production method, the first response was, "They'll wind up in prison." There wasn't even a GOST [state standard] for that in the USSR and that would imply a criminal matter. But the chief designer of the structural frame, A. Potopalov, who is no longer alive, then said, "Let's not stop them, let's give them the opportunity to do it. And if they do it and they put them in prison, I'll go to prison with them and I'll empty the latrine pail everyday..." Such were the boiling emotions. Lozino-Lozinskiy gave the model version two days. After two days, he listened and then shook his head: "This is a madhouse." "And we've stepped into this madhouse...At first, we constructed a mathematical model of the contours. When that didn't work, we spit blood..."

Even now, the CADS guys rush up in the middle of the night to get another gulp of machine time, like it's oxygen. And what do they say about the beginning, when there weren't enough machines, or even walls? They were creating a domestic complex of programs for positional calculations on the contours, and more than 20 organizations took part—the country's leading VUZes, the Ukrainian and Belorussina cybernetics institutes, the Central Aerohydrodynamics Institute. The plant was building a special room at the time, with strict air conditioning and filtration, and it ordered a unique machine for measuring and tracing the body of the craft, plus "oil-less" milling machines with numerical control. The plant gets a data bank with mathematical models of the tiles, makes corrections based on actual measurements and the nuances of the precise surface underneath each and every tile, and assigns the machine tools a program for every single one. That is, with a program for each of the six sides, programs for the felt backings and for the auxiliary mountings. Sixteen programs for each tile.

"We started with 29," the director of the plant says, to be precise. "We've already managed to optimize things. And programs like these, as a product, also don't exist. Otherwise, a storage facility with a microclimate and with twin back-up against water and fire would cost a healthy sum."

There are no drawings or storage facilities; on the other hand, there are almost a hundred mathematical subsystems that control production and quality. The information flows directly from the designer to the machine tools. Perhaps "Buran" will acquaint us with this high road of civilization.

"This is the prototype of the future plant-wide system," says the director, reading my thoughts. "In time, we will escape the mountains of paper and, based on the work on the heat shield, create an automated control system for the entire plant..."



Full-scale test stand for "Buran" equipment

The pilot project, strange as it may seemr, united those who, in their school days, learned by rote the facts about the "bourgeois pseudo-science of cybernetics" and those who, ten years later, were suddenly learning to think in kilobytes and megabytes. It's also an interesting experiment—intellectual, moral, and psychological. Within the program, both a colossal restructuring of ideas and a stormy collision of ideas, concepts, and assumptions are taking place. Not everyone is in complete ecstasy—you must remember that for now, only a small part of the program has been completed, and "Buran" has not yet proved itself in orbital operation.

What will that be like? The letters and telegrams from readers regarding the launch are, similarly, not merely exclamations of joy. "Tonnage, velocities, altitudes, automatic equipment, etc. But where are the mentions of the expenditures, the billions of rubles of public funds? Where is the connection with the public well-being? And where is the mention of the time, the years, that Buran has set back the Food Program, the manufacture of high-quality footwear and clothing, the improvement of medical care for the citizens of the USSR?" reader A. Rudenko, from Kishinev, quite rightly asks.

Is is possible to answer that with a direct, positive answer? Why did a much poorer country, whose war wounds had not yet healed, greet the flight of Gagarin's simple "Vostok" with matchless ecstasy, even though it was clear then, too, that the flight itself would not put more meat on the table or shoes on people's feet.

Of course, emotions have been frittered a bit, and certainly enough promises have been broken over the years. And the "mountains of bread and the infinite power" promised by Tsiolkovskiy are, in the meantime, considered to be abstractions. Although, if they were taken literally, suppose some one were to deprive us of the huge army of automatic satellites—our life will grow dim in all regards and become unrecognizable. But this,

perhaps, is only the beginning of near-Earth development. The main thing is clear: this work is, primarily, not for ourselves, but for posterity. Whether we should spend our money on posterity—that's the point of discussion. And if we don't spend some money—and we doom it to backwardness. That's the decision you must make.

In their post-launch speeches, a whole series of chief designers have explained both the merits of an all-purpose rocket-space transport system and the benefit of spin-offs based on technologies, materials, assemblies, test stands, systems and computer program packages in various fields and sectors. True, who will control the transfer of this technological wealth? Where are the levers and springs governing their widespread use and the demand for them? On one end, we have a relatively high technology (or technology being finely tuned)—the "Buran". And on the other, we have failures and quagmires: Gosagroprom, things in everyday life, shoes, clothing...How do we unite them and bring both sides of the system up to the higher level? This process has begun—that same "Buran" scientific production association has been assigned to engineer and develop an automatic cutting-and-layout complex [raskroyno-nastilochnyy kompleks] for light industry. It'll be on a level that was inaccessible to the old light-and-food industry machine-building.

They talk about making all-weather landings, about establishing universal and independent telephone communications via satellite, and even about bringing down from orbit the "Salyut-7", which has been up there too long...

But still, it seems to me, that, in the main, our leaders have not yet explained things in clear enough terms. Like the fact that this program is virtually set up for the future of all mankind. And today's "Buran", with its entire launch system, is, for now, more than anything else, a prototype of future aerospace systems, which will be more efficient, effective, and economical. And because of that, as well as because of the problems that lend themselves to humanitarian concern, we've got to perfect it.

What does it mean if we can bring a 20-ton object (and later, larger ones) down to Earth from orbit? It means, among other things, rescuing vehicles in distress that have people aboard. It means being able to return vessels and even stations that have gone out of control...

And the problem of burying our nuclear power plant wastes? For now, we are fidgeting with it, as if we were trying to thread a needle. Even though, it would seem, there's a simpler way: put it in a container and send it to the Sun. But through the years, with new technology, those wastes could again become valuable material. It would be a pity. But what if they were put in those same containers, but into a high orbit? Until a better time, when they could be used? That's also work for the 'shuttless.'

Two-hour Moscow-Tokyo or Moscow-New York flights...Taking industries that choke our environment away from the planet...Bringing rust-resistant iron from the Moon...Maybe our leaders are also thinking about this, but they're not saying very much, and then only reluctantly. I won't argue that silent decisions are often, if you will, quite intelligent; but they are offensive to those they affect. Besides, they affect more and more people and have a far-reaching scope.

UDC 629.7

Motion of Satellite Carrying Viscoelastic Rod With Weight on End in Circular Orbit

18660233a Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 10 Oct 87) pp 366-373

[Article by V. G. Demin, Yu. G. Markov and I. S. Minyayev]

[Abstract] The rotation of a mechanical system consisting of a symmetric solid satellite, along whose axis of symmetry there is an extensible viscoelastic rod with a point load on its end, about its center of mass is examined. The problem is formulated in the following way: a coordinate system $Cx_1x_2x_3$ is rigidly referenced to the solid satellite, C is the center of mass of the system in a position when the rod with the point load is situated along the axis of symmetry of the satellite Cx_3 and is linear. The point C, the system center of mass, moves in a circular orbit of the radius R, and the flexural oscillations of the rod exert no influence on its motion. An additional coordinate system is introduced which moves translationally. In this formulation it is therefore assumed that the center of mass moves in a central Newtonian force field. It is shown that the flexural deformations of the rod, accompanied by energy dissipation, are responsible for the evolution of the rotational motion of the system. The approximate equations describing this evolution were derived by the method of separation of motions and averaging. Figures 2; references: 4 Russian.

UDC 629.78.062.2:519.9

Optimal Control of Terminal Accuracy in Reorientation of Spherically Symmetric Spacecraft

18660233b Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 4 Jun 86) pp 374-379

[Article by A. K. Batkin, A. N. Sirotin and K. V. Sochnov]

[Abstract] Spacecraft reorientation involves a process of control of the position of some selected spacecraft axis or a trihedron coupled to it. Usually, the initial angular

velocity is completely extinguished and reorientation is from a position of rest. At the final moment of control it is also necessary to obtain a zero angular velocity for ensuring stability of orientation in the absence of external perturbations. In this article it is shown that by invoking additional reasonings it is possible to obtain a full solution of the problem of optimal control of terminal accuracy of reorientation of a spherically symmetric spacecraft from the initial position of rest to a final position during a given time on the assumption that the spacecraft is an ideally solid body. The solution is obtained by using the maximum principle for problems with a fixed time and a free right end. The necessary optimality conditions which are defined make it possible to obtain an analytical solution of such reorientation problems. It is demonstrated that optimal control satisfies the adequate optimality conditions due to its uniqueness properties. References: 4 Russian.

UDC 531.383+629.05.001

Numerical Analysis of Accuracy of Model of Optimal Programmed Rotation of Satellite Using Flywheel System

18660233c Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 7 Jul 86) pp 380-389

[Article by A. G. Sokolskiy and S. A. Khovanskiy]

[Abstract] The programmed rotation of a satellite by means of an orientation system in which a system of flywheels is used as the controlling actuating elements (the three flywheels have axes of rotation which are parallel to the main central axes of inertia of the entire system) is analyzed. The body of the satellite and the flywheels are assumed to be solid bodies, and the satellite-flywheel system is considered a gyrostat (the moments of inertia of the entire system are constant). With these assumptions, a simple model which is optimal with respect to speed is constructed for the programmed rotation of a satellite in banking angle; the model makes it possible to stipulate requirements on the control system for given satellite parameters and the parameters of programmed rotation. Numerical integration of the equations of motion is used in defining the ranges of possible values of parameters of the satellite-flywheel system ensuring an acceptable accuracy. A system for programmed satellite rotations is described, and numerical estimates of the additional energy required for this purpose are made. Figures 8; references: 8 Russian.

UDC 629.78

Determining Motion of 'Salyut-6' and 'Salyut-7' Orbital Stations Relative to Center of Mass in Slow Turning Mode From Measurement Data

18660233d Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 22 Jul 86) pp 390-405

[Article by V. A. Sarychev, M. Yu. Belyayev, S. P. Kuzmin, V. V. Sazonov and T. N. Tyan]

[Abstract] A method is proposed for determining the rotational motion of the "Salyut-6" and "Salyut-7" orbital stations in a slow (with an angular velocity of less than or equal to 0.2 degree/sec) twisting mode, using the readings of satellite transducers. The transducers make it possible to measure the strength of the Earth's magnetic field and the vector of solar position. The measurement data are processed by the least squares method with integration of the equations of station motion relative to the center of mass. Examples of determinations of real motions are presented. Experimental data were used in studying the motion of the "Salyut-7" station relative to the center of mass during prolonged time intervals. It is shown that several days after the beginning of uncontrolled motion with a small initial angular velocity, the station assumes a specific form of uniaxial gravitational orientation in which its longitudinal axis experiences stable oscillations relative to the local vertical, with an amplitude of about 40°. Figures 5; references: 10 Russian.

UDC 629.785:523.42

Method for Research on Planet Venus Using Floating Balloon Stations. Mathematical Model

18660233e Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 29 Jul 86) pp 430-433

[Article by V. A. Vorontsov, V. A. Deryugin, V. P. Karyagin, R. S. Kremnev, V. V. Kuznetsov, V. M. Linkin, K. M. Pichkhadze, G. N. Rogovskiy and A. V. Terterashvili]

[Abstract] A mathematical model of balloon probes such as those used in the 'Vega' project of 1985 was formulated for understanding the nature of the drift process and correct interpretation of the experimentally collected data. The model rather fully describes both the characteristic and perturbed motion of a balloon during drift. In the model, the balloon has the form of a sphere with the initial volume 19.4 m^3; the envelope thickness is negligible; for the filled balloon it is assumed that there is a linear dependence of balloon volume on excess pressure; the mass of lift gas in the balloon is a linear function of drift time; the change in internal energy of lift gas in the envelope occurs as a result of heat exchange between the gas and envelope walls due to free convection and as a result of atmospherically induced compression or expansion of the lift gas; heat exchange of the envelope with the atmosphere is due to free and induced convection, as well as radiation; envelope temperature is constant in its thickness; the drag coefficient of the balloon envelope is determined with allowance for balloon probe geometry; the basic atmospheric model formulated on the basis of the results of earlier flights of "Venera" stations was used as the computation model. The mathematical model based on these and other assumptions made it possible to model the effect exerted on the balloon by various perturbing factors, such as the ascending and descending vertical wind, both constant and sign-variable; a gravity wave representing simultaneous sinusoidal change in atmospheric density and the vertical wind, with a phase difference of 90° between

them; the effect of the solar wind as a function of zenith angle; and loss of lift gas as a result of diffusion and leakage. Such a model is also applicable to other planets, especially Mars and Jupiter.

UDC 629.785:523.42

Research on Aerodynamic Parameters of 'Vega' Project Balloon Probe

18660233f Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 19 Feb 88) pp 434-440

[Article by S. N. Aleksashkin, V. P. Karyagin, K. M. Pichkhadze, R. Ch. Targamadze and A. V. Terterashvili]

[Abstract] The aerodynamic parameters of the balloon probe constituting part of the "Vega-1" and "Vega-2" spacecraft are analyzed. (The placement of the balloon in the upper hemisphere of the descent module is illustrated in Fig. 1,a and its design, in Fig. 1,b; a table lists the various operations involved in the Venusian atmosphere.) Investigation of the balloon probe included the stages of determination of its static aerodynamic parameters, status of the balloon envelope in different phases of its filling, estimates of balloon probe dynamics relative to the center of mass and the envelope in the course of filling in wind tunnels, and implementation of a full-scale flight experiment in the Earth's atmosphere. The method used in wind tunnel tests is described; and the dependence of the stationary aerodynamic parameters of the balloon probe on angle of attack, glancing angle and relative distance of the balloon probe from the upper hemisphere of the heat-insulating envelope is determined, as are the dependence of the angular velocity of steady rotation relative to the velocity vector of the oncoming flow and the dependence of the load on the envelope of the balloon probe on the degree of its filling and the nature of its dynamics. Figures 5; references: 3 Russian.

UDC 629.785:523.42

Research on Dynamic Parameters of Sensor of Vertical Wind Speed Component. 'Vega' Project Balloon Experiment

18660233g Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 1 Sep 87) pp 441-447

[Article by S. N. Aleksashkin, R. I. Zukakishvili, K. M. Pichkhadze, R. Ch. Targamadze and A. V. Terterashvili]

[Abstract] The dynamic parameters of the sensor for the vertical wind speed component used in the "Vega" project balloon experiment were investigated. The sensor consists of a cylindrical housing mounted in a holder by means of bearings and an impeller consisting of eight rectangular plate-blades between which there are film tabs (Fig. 4 is a diagram of the sensor). The theory of the instrument is described. The study of the dynamic parameters of the wind sensor included experimental determination of the "speed of the oncoming flow - angular velocity of rotation of impeller" transfer function, its dependence on the design parameters of the sensor, and on this basis, an analysis of the spectral density of the error in registry of flow velocity change. It was found that due to the dynamic properties inherent in the sensor and balloon the error minimum is attained in a narrow range of input signal frequencies to 0.1 Hz, which makes it possible to evaluate the slowly changing drift of mean velocity of the vertical turbulence of the atmosphere of Venus. The resulting data were used in an analysis of information from the "Vega" project balloon experiment. Figures 8; references: 5 Russian.

UDC 629.785:523.42

Flight Experiment for Debugging Balloon Probe

18660233h Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 3, May-Jun 88 (manuscript received 9 Jul 86) pp 448-456

[Article by V. P. Karyagin, R. S. Kremnev, V. V. Kuznetsov, V. M. Lashmanov, V. P. Nikiforov, Ye. N. Nozdrachev, K. M. Pichkhadze, I. A. Sklovskaya and A. V. Terterashvili]

[Abstract] The objective of the flight tests carried out when developing the "Vega" project was the collection of data on the reliability of functioning of the descent module as a whole, the lander, and the balloon probe under conditions as close as possible to real use. A positive evaluation was given if an analysis of the experimental data indicated that a module and its systems functioned according to design calculations. The term "flight tests" as applicable to this problem (testing of functioning of mockup during independent motion in the earth's atmosphere in modes partially or completely simulating the descent of the descent module in the real atmosphere of the investigated planet) is defined. The choice of trajectory segments requiring experimental checking in a flight experiment is made by mathematical modeling of vehicle descent. This modeling demonstrated the possibility of carrying out simulation flight tests in the Earth's atmosphere, including filling of the balloon envelope, if the filling begins at an altitude greater than 4 km. Four schemes for conducting a flight experiment (rocket, aircraft, balloon, helicopter) are described and illustrated by diagrams. The results of these tests made it possible to improve probe design and the method for monitoring its entry. The experimental data made it possible to satisfy all the test objectives, and the tests confirmed the correctness of the solutions adopted in the designing and construction of the balloons, the lander, and descent module as a whole. Figures 3; references: 2 Russian.

UDC 521.1

Secular Effects in Translational-Rotational Motion of Orbital Station Having Artificial Gravity

18660138 Dushanbe DOKLADY AKADEMII NAUK TADZHIKSKOY SSR in Russian Vol 30 No 7, Jul 87 (manuscript received 25 Feb 87) pp 417-419

[Article by D. Z. Koyenov, Tajik State University imeni V. I. Lenin]

[Abstract] The most promising variant of an orbital station having artificial gravity involves use of a long cable for joining two spaceships and putting them into rotation about some axis passing through their common center of mass, which moves in a definite orbit around the Earth. Artificial gravity can be regulated by changing the length of the cable (such as by a winch). "Terrestrial," "Martian" or any other kind of gravity can be created aboard an orbital station in this way. This possibility is illustrated for the case of two spherical figures of an identical radius, connected by a long cable, rotating about an axis passing through their common center of mass, thereby producing the equivalent of terrestrial gravity. The translational-rotational motion of such a station around the Earth is examined (solutions of the averaged differential equations of satellite motion were given by the author in DOKL. AN TADZH. SSR, Vol 19, No 1, 1976). Solution of these equations reveals that all the pertinent elements remain constant during the entire time of motion and equal to their initial values. It is shown that the examined configuration of orbital station exerts a substantial influence on the Delaunay elements (on translational motion of the station around the Earth). Formulas are given showing that configuration of an orbital station exerts no influence of a secular nature on the rotational motion of an orbital station about the nutational axis. Figure 1; references: 2 Russian.

UDC 629.783

Spatial Evolution of Vector of Residual Accelerations Aboard Spacecraft

18660010a KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 26 Feb 86) pp 621-625

[Article by V. S. Avduyevskiy, A. I. Likhoded, V. V. Savichev, V. B.Dubovskoy, S. S. Obydennikov, and M. I. Pleshchinskiy]

[Abstract] Since absolute weightlessness on a spacecraft is virtually unattainable, uncompensated moments of forces are operative and a field of residual small accelerations arises. This is a factor which affects melts during the heating and crystallization processes and therefore is highly important in the course of technological processes aboard a spacecraft. Computations of these small accelerations require use of a mathematical model in which allowance is made for all the operative factors, all external and internal perturbations. The different types of instrumentation used for measuring small accelerations on the "Salyut-6" and "Salyut-7" orbital stations, "Progress" transport ships and flying laboratories are reviewed. The combination of theoretical research and instrumental measurements indicated the steps necessary in order to ensure the highest quality technological operations aboard a spacecraft. A method and computation scheme were developed for the purpose of evaluating, by simulation, the accelerations arising during actions of operators in a trainer (such as walking or jumping). Figures 2; references 7: 6 Russian, 1 Western.

UDC 531.352

Stabilization of Rotation of Heliocentric Satellite With Solar Sail

18660010b Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 26 No 4, Jul-Aug 88 (manuscript received 13 Dec 87) pp 625-628

[Article by T. A. Rybnikova, T. F. Bulatskaya and A. V. Rodnikov]

[Abstract] A study was made of the translational-rotational motion of a heliocentric satellite consisting of a solid body and a plane plate rigidly coupled to one another by a rod joining the center of mass O of the entire system and the geometrical center of the plate O1. This plate serves as a solar sail. The problem is examined in a restricted formulation (it is assumed that the interaction of orbital and rotational motions can be ignored). Two coordinate systems are referenced to the satellite: orbital Oxyz (with the Oz axis directed toward the sun) and a system for the main central axes of inertia of the satellite. Assuming that the center of mass moves in a circular heliocentric orbit of a sufficiently great radius, rotation of the system of axes Oxyz and the moments related to nonuniformity of the field of force can be ignored. The sail is assumed to be an ideally black body. In this formulation of the problem, the objective is to reduce satellite rotation to permanent rotation about the axis of dynamic symmetry using a suitably selected series of "switchings" of the u parameter (u is a parameter equal to unity if the sail is "open" and equal to zero if the sail is "closed"). After derivation of the pertinent equations of motion, an effective stabilization program is written which provides a solution to the problem. Figures 2; references 6: 4 Russian, 2 Western.

'Topaz' Nuclear Power Plants for Space Vehicles Developed

LD0501122089 Moscow TASS in English 1159 GMT 5 Jan 89

[Text] Moscow January 5 TASS—By TASS scientific observer Nikolay Zheleznov:

Soviet scientists and engineers are stepping up the quest for non-traditional energy sources for space vehicles. Another step in this direction was made last year: a series of flight tests of a new thermoemission nuclear energy-generating installation were carried out. Two 10-kilowatt power installations were launched on board Cosmos satellites. One of them successfully functioned in orbit for six months and the second one for a year.

Taking into account the lively interest displayed by world scientific circles in these developments, the USSR State Committee for the Use of Nuclear Power is sending a group of specialists who took part in the development and testing of new energy sources to Albuquerque, in the United States, where a symposium on space power engineering opens on January 6.

The flight tests are the result of many years' work under the Soviet "Topaz" program. Georgiy Gryaznov, one of the heads of the program who will also attend the Albuquerque symposium, said that a nuclear reactor which is a combination of a heat source (the Tvel heat-producing element) and a thermoemission transformer had become a basis of a compact and comparatively light energy source which practically does not consume fuel. Because of its high efficiency the reactor can well be used in future power-intensive space vehicles.

Professor Gryaznov pointed out that for the purpose of ensuring radiation safety high-orbit satellites had been used in flight tests. Their passive existence time is about 350 years, which is enough for the decay of fission products to a safe level. The installations were maneuvered and brought to full capacity on orders from the earth. This method of ensuring radiation safety, that has been tested in the USSR on more than one occasion, can serve as a basis for further developments connected with the creation of safe space vehicles with nuclear power sources.

Use of Nuclear Propulsion for Interplanetary Flights Called Feasible

18660058 Moscow PRAVDA in Russian 16 Oct 88 p 4

[Excerpt] As has been reported in the press, the critical final stage of the flight of the satellite "Cosmos-1900," which was equipped with a nuclear power plant, was carried out successfully on 1 October of this year.

TASS commentator N. Zheleznov asked Doctor of Technical Sciences, Professor G. Gryaznov to comment on this operation in space and on prospects for the advancement of this new direction in power engineering.

"Development of space nuclear power plants is a fundamentally new direction of power engineering and a vivid example of interdisciplinary character of contemporary science and technology," said the scientist.

Gryaznov emphasized that painstaking work on problems of radiation safety was already in progress when plans for using nuclear power plants in space were in the discussion stage. If a nuclear power plant is intended for use in a low orbit, safety is ensured by shifting the spent plant to an orbit of prolonged duration (about 300 years), where its radioactive materials will in fact be entombed after the satellite has completed its program.

The use of nuclear power plants in radiation-safe orbits opens up broad prospects for introduction of nuclear power in spacecraft intended for economic purposes.

Nuclear power plants could play an important part in interplanetary flights. According to estimates which Soviet specialists have made, a multimegawatt nuclear plant can create the exhaust thrust which a spaceship needs in a flight to Mars.

Advantages of 'Kurs' Spacecraft Docking System

18660059 Moscow TRUD in Russian 1 Sep 88 p 1

[Article by V. Golovachev, special correspondent at the Flight Control Center]

[Excerpt] "Soyuz" spaceships docked with earlier-generation space stations of the "Salyut" series with the aid of a system called "Igla."

A new docking system called "Kurs" which is installed on the orbiting complex "Mir" is far more reliable than the "Igla" and opens up broader possibilities. For example, the "Kurs" equipment begins to operate when the distance between a spaceship and the orbiting complex is about 400 kilometers, which is 10-15 times greater as compared with the "Igla." Mutual orientation of both the ship and the station was formerly necessary. When "Kurs" is in operation, the "Mir"—"Kvant"—"Soyuz" complex does not rotate but flies in a certain position. All maneuvers are performed by the approaching transport ship.

Two docking systems, the older "Igla" and the new "Kurs," are installed on the orbiting complex. The "Kurs" system demonstrated its capabilities brilliantly [on 31 August].

An American correspondent asked General-Lieutenant of Aviation V.A. Shatalov, head of the Cosmonaut Training Center: "What are your plans for the future?"

"A transport spaceship has a service life of approximately half a year. This means that ships must be replaced every six months; a visiting crew flies to the station in one "Soyuz," leaves it there and departs in another. It can be said on this basis that a flight must be made approximately in April or May of 1989 and another flight six months after that."

Developers Discuss Features of Spacesuits

18660071 Moscow PRAVDA in Russian 9 Dec 88 p 2

[Article by G. Severin, Doctor of Technical Sciences, Professor; I. Abramov, Candidate of Technical Sciences]

[Abstract] The authors, who are identified as developers of spacesuits, tell about suits which are now in use. Features of spacesuits intended for use by crews of spaceships in emergencies are compared with those of suits intended for use during EVAs into open space.

The authors comment in particular on an original EVA suit of the semirigid type which was used for the first time in 1977, on the orbiting station "Salyut-6," and on a modification of this suit which went into service recently. The upper part of a semirigid suit has a metal cuirass shell, the authors related. It and the helmet form an integral unit. The suit's lower parts and gloves are made of elastic materials. A self-contained life-support system is installed on the suit's back, which serves simultaneously as the cover of an access hatch. The design of this hatch enables the wearer to get in and out of the suit in a few minutes. The structure of the spacesuit's outer shell makes it possible to maintain a positive pressure of about 0.4 atmosphere inside the suit. This practically eliminates the possibility that the wearer will develop decompression illness in passing from the 'terrestrial' pressure inside the space station to the lower pressure inside the suit, and substantially reduces time for desaturation of a cosmonaut's organism prior to an egress. For the purpose of ensuring the wearer the necessary mobility under positive pressure, the suit is equipped with specially developed airtight bearings and 'soft' joints. A water-cooled suit protects the wearer against overheating during the most strenuous physical work.

The authors note that spacesuits on board the orbiting station "Mir" have been in service for more than two and a half years. Five EVAs with an overall duration of more than 18 hours have been made into open space by cosmonauts wearing these suits. The authors acknowledge that irregularities have sometimes been encountered with the suits. During preparations for an egress from the orbiting station "Salyut-7" in October of 1983, for example, cosmonauts V. Lyakhov and A. Aleksandrov discovered a break in the pressure-tight outer shell of a suit. The cosmonauts had the difficult task of repairing the suits on board the station.

A set of newly modified spacesuits of the semirigid type was delivered to the "Mir" station by "Progress" spaceships, it is recalled. As compared with the earlier suit, the modified one enables the wearer to work without a multiple-conductor electric cable connecting the suit to onboard systems of the station. The modified suit has a removable attachment with self-contained radio telemetry equipment and power sources, as well as additional operating controls. Safety features of the suit include duplication of shells and of vitally important systems, a system for monitoring main operational parameters of the suit's life-support system, and light and sound signaling for warning the wearer of hazardous situations. The authors mention that the flight training program of cosmonauts Jean-Loup Chretien and Michel Tognini included eight exercises with the modified suits, during which conditions at maximum altitudes were simulated in heat-and-pressure chambers.

UDC 550.34:629.78

Experience in Detection of Seismically Dangerous Fault Dislocations in Dushanbe Downwarp on Space Photographs

18660004a Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 88 (manuscript received 14 Apr 87) pp 36-40

[Article by Yu. N. Pilguy and A. K. Gayazova, Tadzhikaerokosmogeodeziya Scientific-Production Association, Dushanbe]

[Abstract] The Dushanbe downwarp, part of the Tajik depression, has been well studied by traditional geological-geophysical methods, and many fault dislocations have been clearly defined. The interpretation of space photographs with different levels of generalization obtained from various satellites has revealed the existence of many lineaments of latitudinal, submeridional and diagonal strikes within the downwarp region and the borderlands to the north. The submeridional and diagonal lineaments are probably a surface expression of recent disjunctive dislocations cutting the structures across their strike. These lineaments are discriminated on the basis of the features of their expression in the present-day relief on space photographs obtained at the global and regional generalization levels in the visible, near-IR and IR parts of the spectrum. Morphosculptural and morphostructural relief forms are indicators of lineaments in areas from which sediments have been stripped away, whereas in areas buried beneath sediments they are identified in the form of lines of brighter or darker phototone and are emphasized by the nature of the hydrographic network. This article describes the most important of these lineaments (Ilyakskiy, Predgissarskiy, Bogainskiy, Iosskiy, Bogikalonskiy, KafirnigANSkiy, Fayzabadskiy), including those studied earlier by traditional methods and those detected in the interpretation of space photographs, and their relationship to the faults identifier earlier. All these sectors must be studied carefully by surface methods for determining the degree of their activity so that these features can be taken into account in industrial and civil construction work and in predictions of seismic activity. Figure 1; references: 8 Russian.

UDC 551.25:629.78

Engineering Evaluation of Exodynamics of Mountainous Relief Using Space Survey Data

18660004b Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 88 (manuscript received 12 Jan 87) pp 41-48

[Article by A. L. Revzon, A. P. Bgatov, A. I.Bogdanov and A. M. Bogdanov, All-Union Scientific Research Institute of Transport Construction, Moscow]

[Abstract] Safety in construction work and operation of transportation facilities in mountainous regions requires an ongoing engineering evaluation of the development of exogenous geological processes for validation of decisions on the placement of structures. Such an evaluation is considerably more complete and reliable if it is based on an analysis of special maps of endogenous geological processes compiled using data from the interpretation of space photographs, with subsequent automated processing of the interpreted data. The interpretation of exogenous geological processes involves the identification and systematization of as much information as possible on exodynamic conditions unfavorable for construction. The article describes the mapping procedures which should be used and the steps required for processing interpreted space photograph data applicable to the engineering planning of transport structures (railroads and highways) in areas with extensive development of exogenous geological processes. The methods, which also involve engineering and cost calculations, are illustrated in specific examples. Figures 2; references: 3 Russian.

UDC 551.46.0:629.78

Possibilities for Using Space Information in Studying Pollution Processes and Eutrophication in Lake Systems

18660004c Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 88 (manuscript received 25 Jul 86) pp 49-57

[Article by K. Ya. Kondratyev, V. V. Bruk, G. V. Druzhinin, L. K. Yegorov, I. I. Malykhina and F. T. Shumakov, Limnology Institute, USSR Academy of Sciences, Leningrad; All-Union Scientific Research Institute for Water Conservation, Kharkov]

[Abstract] Methods for using aerospace information for monitoring the processes of pollution and anthropogenic eutrophication of internal water bodies have been developed since 1981. The basin of Lake Ladoga, which contains water masses of different types, has been the principal object for such subsatellite research. This article gives the results of such work based on the use of multizonal space information for quantitative evaluations of the spatial-temporal distributions of water quality indices. Over the course of 15 years the phosphorus concentration in lake water has almost tripled. In less than 20 years Lake Ladoga has been transformed from an oligotrophic to a mesotrophic water body. This article gives the results of subsatellite hydrooptical, hydrochemical and hydrobiological investigations of Lake Ladoga and its main tributaries (1982-1984). The following water quality indices were determined: temperature; pH; conductivity; transparency; content of dissolved oxygen and chlorophyll a, b and c; total chlorophyll content; concentration of suspended matter; content of organic and inorganic suspended matter; and total phosphorus content. The subsatellite measurements were made on days of "Cosmos" and "Meteor" satellite surveys. There are significant correlations between the concentrations of suspended matter, conductivity, total phosphorus, transparency, content of chlorophyll a and b and the optical transmission coefficients of duplicate negatives

of multizonal space photographs. For not one of the multizonal space survey channels were there any significant correlations for the content of dissolved oxygen, pH or chlorophyll c. The nonlinear nature of the correlations must be taken into account in writing the regression relations for quantitative evaluations of water quality indices determined from space surveys. Multiple regression methods, taking the multicollinearity phenomenon into account, must be used for separate determination of water quality indices correlating with space image parameters. Figures 4; references 9: 7 Russian, 2 Western.

UDC 551.525+551.526:629.7

Allowance for Selective Absorption in Determining Temperature of Earth's Surface by Angle Method

18660004d Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 88 (manuscript received 26 Aug 87) pp 66-76

[Article by A. K. Gorodetskiy and N. G. Mamedov, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] As a result of great variations in water vapor content there is a change in both its contribution to the total attenuation of radiation from the Earth's surface and the relation between selective and continuum attenuation of radiation. A method for taking selective absorption by water vapor into account is proposed which makes it possible to reduce the error in determining surface temperature. The method is described in the following sections: line-by-line and approximate computation of selective absorption of radiation by water vapor; relation of selective and continuum absorption by water vapor; allowance for selective absorption in determining surface temperature. Application of the method for taking selective absorption into account is illustrated using "Cosmos-1151" data. On the basis of model computations made with allowance for continuum and selective absorption by atmospheric gases it was possible to define the spectral sectors 10.2-11.15 and 10.5-11.5 μm, which can be recommended for making measurements of the angular distribution of radiation intensity. Measurements in the mentioned spectral intervals in the range of air masses 1-2, in combination with the described method for joint allowance for continuum and selective absorption by water vapor, ensure recovery of surface temperature with an error of about 0.5 K. A decrease in errors in determining surface temperature is attained by additive corrections dictated by the variable relation of the contributions of different mechanisms for the attenuation of radiation in the atmosphere. These corrections are dependent on the measured radiation intensities, and they are introduced in the course of solution of the system of equations for the intensities of outgoing radiation. Figures 3; references 22: 11 Russian, 11 Western.

Color Television Image as Quasi-Cross-Section of Signature Brightness Cube

18660004e Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 88 (manuscript received 16 Feb 87) pp 90-92

[Article by V. I. Borisenko and R. V. Ilinskiy, Space Research Institute, USSR Academy of Sciences, Moscow]

[Abstract] In the pixel-by-pixel classification of spectrozonal images the joint visualization of three measurements of the vector signature considerably broadens the possibilities of interactive digital processing procedures. A three-component representation makes it possible to observe the field of natural colors on the screen of a color half-tone monitor for the case of a three-zone initial image obtained in the red, green and blue zones of the visible spectrum or the field of artificial colors for other images or their samples. In the proposed method the spatial operations are reduced to a plane two-dimensional representation on a monitor screen and analysis of this image. Due to complexities of the apparatus and programs and the great time expenditures in the visualization of three-dimensional digital fields the traditional interactive teaching procedures are inefficient; this dictated development of the new method, consisting of three stages (each of which is described). This involves, for example, use of the parallelpipeds method, which has been modified by introducing the quasi-cross-section concept, which is discussed. A program was written which breaks the classification stage down into three successive procedures, which are outlined. The method employs spectral characteristics and evaluates the spectral and geometric proximity of pixels. Programs developed at the Space Research Institute make it possible to carry out a classification by the described method, descriminating up to 16 classes of objects. Individual programs have been developed for monochrome, two-component and color images which make possible the most complete use of system capabilities. References 5: 3 Russian, 2 Western.

UDC 629.19:551

Role of Informational Indices in Selecting Geometrical Parameters of Scanner Survey

18660004f Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul 88 (manuscript received 7 Jan 1987) pp 93-97

[Article by A. S. Batrakov, A. Yu. Anatolyev and Ye. A. Chevychelov]

[Abstract] Informational indices are among the important factors determining the choice of survey parameters. The most significant of these are linear resolution, coverage and number of transmitted brightness gradations. The linear resolution and coverage are directly related to the geometrical parameters of the survey. The role of these indices in the choice of survey parameters has only

been examined partially and for the most part on a qualitative basis. This article clarifies the conditions under which maximal coverage is achieved, how the detail of the registered information changes within the limits of the scanned zone and how the informational properties of the survey materials are related to the intensity of the information flow. For example, a study was made of how the optimal survey altitudes and scanning angles which ensure maximal coverage by a system with a guaranteed image quality are determined (under the condition that the size of a resolved element in the photograph field does not exceed some limiting value). A formula is derived which in implicit form makes it possible to obtain an analytical solution of the optimization problem, and a formula is given which describes a scanning zone with optimal parameters. Expressions are presented which make it possible to obtain scanner survey parameters in generalized form as a function of a dimensionless parameter which is introduced. A table gives the optimal survey parameters for a maximal scanning zone. A study was made of the joint influence of a series of other informational indices and restrictions on the values of some survey parameters. Figures 3; references 8: 7 Russian, 1 Western.

UDC 502:629.782

Foreign Experience in Organizing Collection and Use of Subsatellite Oceanographic Data During Period of Operation of Artificial Earth Satellites

18660004g Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 88 (manuscript received 23 Feb 87) pp 111-119

[Article by G. A. Grishin and Yu. V. Kikhay, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] The foreign literature on organization and use of subsatellite oceanographic data is reviewed and generalized. At present the main form of oceanic research that uses artificial earth satellites (AES) is the well-prepared experiment that makes extensive use of subsatellite measurement systems, including international projects and programs. Satellite sensing systems have a high stability. Experience has shown that it is economically more advantageous to achieve a high stability of on-board devices for calibrating measurement transducers and systems for standard metrological checking than to use data from subsatellite measurements made in special test ranges as reference signals. The principal form of oceanographic analysis of satellite data is the special processing of images by computers, equivalent to synoptic analysis in meteorology. The processing of images in the visible and IR spectral ranges is most common. Research on entire regions of the ocean observed by AES during prolonged time intervals, from several months to several years, is becoming increasingly common. Research is being done on the spatial-temporal variability of highly important physical fields in the ocean and atmosphere. The principal fields of application of oceanographic satellite data are physical oceanography, practical meteorology, climatology, fisheries, hydrography and support services for aviation and shipping. A new generation of oceanological satellites outfitted with the latest remote sensing apparatus is expected to appear in the late 1980's. Various major international oceanographic experiments are being planned which will assist in elaborating the fundamental principles for global and regional monitoring of hydrophysical fields in the ocean. Work has been initiated on realization of a unified global system for the collection, systematization, processing, recovery and dissemination of satellite and subsatellite data. Figure 1; references 30: 3 Russian, 27 Western.

Satellite-Aided Marine Communication Systems

18660222 Moscow VODNYY TRANSPORT in Russian 7 May 88 p 4

[Article by L. Pchelyakov, head of the department of satellite communications systems and radio position finding of the All-Union Marine Satellite Communications Association]

[Excerpt] The merchant fleet now has its own satellite-aided system of marine communications. It consists of three "Gorizont" satellites, ground stations, channeling equipment and a stock of "Volna-S" shipboard satellite-communications sets. The system's satellites and "Orion" ground stations are deployed in such a way that their zone of coverage takes in three oceans: the Atlantic, Indian and Pacific. The system is particularly effective in areas of the Arctic and the Far East, where it is the only stable and routinely operable type of ship-to-shore communication, because of magnetic storms and other atmospheric disturbances. More than 300 ships and offshore oil platforms are now equipped with satellite-communications sets.

The types of communications which the satellite system ensures at all times in areas of the world's oceans which lie between 75 degrees North and South latitude include the following: priority communications in the event of emergencies and in ensuring navigational safety; telephone, telex, telegraph and facsimile communications; and intermediate-speed data transmission.

Plans call for development by 1990 of a new generation of marine satellite-communications equipment employing small shipboard sets and new principles of information transmission which heighten its reliability.

Shipboard equipment, "Ekran-KRS," has been developed in the Soviet Union for reception of Central Television programs. Satellites of the "Ekran" system which serve areas of Siberia and the Far North ensure reception of these programs. There satellites relay television signals and radio programs simultaneously. Each

satellite is equipped with a powerful onboard transmitter (200 watts) and a pencil beam antenna. All problems connected with the functioning of the system should be solved by the end of 1990.

Utilizing capabilities of the "Ekran" system, scientists and engineers have found ways of transmitting pictures of ice conditions obtained from meteorological satellites to icebreakers operating on the Northern Sea Route, during breaks in Central Television programming. These pictures are accompanied by hydrometeorologists' explanations. This system is called TAIS, which is an acronym of "Arctic television information system."

Testing of the system ends this year. It will be accepted for experimental operation and support navigation on the Northern Sea Route.

FTD/SNAP

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Statistical Processing of Data on Spectral Brightness Coefficients for Typical Underlying Surfaces in USSR

18660012 Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 302 No 2, Sep 88 (manuscript received 20 May 87) pp 301-303

[Article by G. A. Ivanyan, K. Ya. Kondratyev, academician, and G. A. Putintseva, Leningrad State University]

[Abstract] In an earlier study (TRUDY GGO, No 434, pp 72-83, 1980) K. Ya. Kondratyev, et al. presented maps of the spectral brightness coefficient (SBC) of characteristic types of surface in the USSR for the summer season in the spectral ranges 0.54-0.56, 0.67-0.69 and 0.77- 0.80μ. Data were also given on the SBC of the defined types of surfaces in the spectral range 0.44-0.46μ and the choice of these spectral intervals was validated for a multipurpose aerospace survey of the Earth's surface. The article also described the method for compiling SBC maps of large territories, a method for the comparison of SBC data obtained by different authors and a comparative analysis of SBC maps. The SBC maps were constructed using data for the 25 most characteristic surface types: tundra (3), forest (6), steppe and meadow with agricultural crops (4), swamp (2), desert and semidesert surfaces (6) and glaciers, water surfaces, populated and industrial centers, river valleys and deltas (1 each). The mean SBC values were computed for each of the spectral ranges. Data were used for nadir observations, solar altitudes greater than 35° and cloudless and little-cloudy weather for the same month (July). A map of the USSR at 1:4 000 000 was broken down into 14 000 squares. The mean weighted SBC values in the mentioned spectral intervals were computed for each square with allowance for the types of surfaces present in the squares. These values were then plotted on contour maps. The results of statistical processing of these SBC data are given: standard deviation, asymmetry, excess and variation were computed and given in a table and histograms of the distribution of SBC squares were constructed. The histograms for the spectral intervals 0.44-0.46, 0.54-0.56 and 0.67-0.69μ are characterized by sharp maxima and a strong right-sided asymmetry. The histogram for the spectral interval 0.77-0.80μ has a somewhat lesser steepness and a left-sided asymmetry. The distribution of squares by SBC values differs greatly from a normal distribution. The results can be used in solving different practical problems, especially for determining the parameters of a system for a multipurpose aerosurvey survey of the Earth's surface. Figures 2; references: 1 Russian.

Death of Space Scientist Academician Valentin Glushko

TASS Notes Scientific 'Talent'

LD1201183789 Moscow TASS in English 1828 GMT 12 Jan 89

[Text] Moscow January 12 TASS—Academician Valentin Glushko, an outstanding scientist and space rocket designer, died here at the age of 80 after a grave illness.

An obituary signed by Mikhail Gorbachev and other Soviet party leaders and statesmen as well as prominent scientists and designers noted his guidance of development efforts to create spacecraft, orbital stations and the reusable space system Energiya-Buran.

It said that Glushko's marked talent and his versatile knowledge in many areas of science and technology enabled him to successfully cope with tasks set by the party and the government.

Leaders Sign Obituary

PM1301154789 Moscow PRAVDA in Russian 13 Jan 89 Second Edition p 8

[Obituary of Academician V.P. Glushko]

[Excerpts] Twice Hero of Socialist Labor Academician Valentin Petrovich Glushko, general designer, member of the CPSU Central Committee, USSR Supreme Soviet deputy, and Lenin and USSR State Prize winner, died in his 81st year after a serious illness on Moscow 10 January 1989. V. P. Glushko was an outstanding scientist and designer in the field of rocket and space technology and one of the closest comrades-in-arms of Sergey Pavlovich Korolev. Glushko made a great contribution in the creation and development of liquid-fuel rocket engines. Under his leadership were created space ships, orbital stations, and the "Energiya"-"Buran" multiple-use space system.

V. P. Glushko was born in Odessa on 2 September 1908. After graduating from Leningrad State University in 1929, he worked in a number of scientific research institutes and design organizations where he dealt with the development of rocket engines. In 1974 he headed the collective which had been created by S. P. Korolev.

His brilliant talent and wide-ranging knowledge in many fields of science and technology enabled him to successfully cope with the tasks set by the party and the government. [passage omitted]

[Signed] M. S. Gorbachev, V. I. Vorotnikov, L. N. Zaykov, Ye. K. Ligachev, V. A. Medvedev, V. P. Nikonov, N. I. Ryzhkov, N. N. Slyunkov, V. M. Chebrikov, E. A. Shevardnadze, V. V. Shcherbitskiy, A. N. Yakovlev, A. P. Biryukova, A. V. Vlasov, A. I. Lukyanov, Yu. D. Maslyukov, G. P. Razumovskiy, Yu. F. Solovyev, N. V. Talyzin, D. T. Yazov, O. D. Baklanov, I. S. Belousov, L. A. Voronin, I. S. Silayev, B. L. Tolstykh, G. I. Marchuk, O. S. Belyakov, V. I. Shimko, V. K. Mesyats, V. Kh. Doguzhiyev, V. M. Belousov, N. V. Gorshkov, I. V. Koksanov, V. G. Kolesnikov, E. K. Pervyshin, L. D. Ryabev, A. S. Systsov, P. V. Finogenov, Ye. P. Velikhov, K. V. Frolov, V. I. Smyslov, V. L. Koblov, S. A. Afanasyev, V. S. Avduyevskiy, V. P. Barmin, V. A. Kotelnikov, V. I. Kuznetsov, M. F. Reshetnev, R. Z. Sagdeyev, G. P. Svishchev, A. N. Tikhonov, V. F. Utkin, Ye. A. Fedosov, O. N. Shishkin, R. R. Kiryushin, V. A. Kurochkin, A. A. Maksimov, S. S. Vanin, G. F. Grigorenko, A. I. Dunayev, V. V. Lobanov, A. S. Matrenin, V. Ye. Sokolov, V. N. Soshin, A. Ye. Shestakov, A. A. Borisenko, V. D. Vachnadze, V. I. Gubanov, L. I. Gusev, G. A. Yefremov, N. I. Zelenshchikov, V. M. Kovtunenko, D. I. Kozlov, A. D. Konopatov, L. N. Lavrov, V. L. Lapygin, G. Ye. Lozino-Lozinskiy, Yu. A. Mozzhorin, S. P. Polovnikov, D. A. Polukhin, V. P. Radovskiy, Yu. P. Semenov, A. A. Chizhov, G. S. Titov, K. A. Kerimov, V. A. Shatalov, V. V. Ryumin.

State Commission System in Soviet Space Program

18660016 Moscow ZEMLYA I VSELENNAYA in Russian No 5, Sep-Oct 88 pp 73-79

[Article by Yu. A. Skopinskiy; "State Acceptance of the Space Program: Thirty Years of Work"; article appears in source under the rubric "From the History of Science"]

[Text] After a thorough review, the State Commission gave permission for the launch on 4 October 1957 of a Soviet artificial Earth satellite, the first in the world. That was essentially the beginning of the work done by the state acceptance agency for the space program.

"Comrade chairman of the State Commission!" That phrase has long been well known to tens, and even hundreds, of millions of people on Earth. That is how, since the adroit hand of Yuriy Gagarin, the commanders of crews of manned spacecraft traditionally begin their report at Baykonur, signaling their readiness for the flight, and at Zvezdnyy Gorodok, upon their return home to mother Earth. The reports on this emanate from the radio, are shown on television, and are printed in newspapers and magazines. Over the years of manned flight, more than 60 crew commanders in all have reported to the chairmen of the State Commission before taking their places in the cabins of the Vostoks, the Voskhods, and three versions of the Soyuz.

And yet, that phrase rang out even earlier and is enunciated considerably more often "for the staff," when the chief designer and the heads of the cosmodrome and the measurement and control complex report to the chairman of the State Commission on readiness for launch and flight control of unmanned (or automatic) spacecraft.

The first such spacecraft, as everyone knows, was placed into near-Earth orbit more than 30 years ago, on 4 October 1957. Taking part in the preparations, the launch, the trajectory measurements, and the flight control were hundreds of scientific research institutes, design bureaus, plants, observatories, computer centers, and radio, ionospheric, and optical communications and time stations.

The work of those groups had to be well coordinated and strictly monitored both during the preparations and during all stages of the performance of that unusual and grandiose space-rocket experiment. The plethora of questions and problems that arose had to be resolved promptly and competently, and the efforts of a great many organizations had to be kept on track and "spliced together." It must also be kept in mind that some of the organizations were separated by hundreds, even thousands of kilometers and were part of several state commissions and sovnarkhozes [councils of national economy]. Overcoming departmental barriers was, indeed, sometimes harder than overcoming the great distances. Coordinating the activity of this immense collaboration of enterprises separated by distance and departments was the Special Committee of the USSR Council of Ministers. When, however, in all its urgency and grandioseness, the matter of the immediate preparation and performance of the "first and great step of mankind," as K. E. Tsiolkovskiy labeled the development of an artificial Earth satellite, appeared on the agenda, a more effective, single-tracked leadership organ was needed. And that was the first State Commission of, so to speak, a space profile. Confirmed as the chairman of the commission was the prominent leader of socialist industry, Vasiliy Mikhaylovich Ryabikov (1907-1974), who had headed the Special Committee mentioned above. The immense experience of V. M. Ryabikov and the profound skills of technology and production greatly facilitated the successful work of the commission he headed in the creation of the world's first artificial Earth satellite. Working in the commission were major scientists and designers, heads of scientific research institutes and design bureaus, and organizers of science and production. They included the technical director of the work and deputy chairman of the commission S. P. Korolev, M. I. Nedelin, M. V. Keldysh, V. P. Glushko, N. A. Pilyugin, M. S. Ryazanskiy, V. P. Barmin, V. I. Kuznetsov, G. N. Pashkov, K. N. Rudnev, S. M. Vladimirskiy, G. R. Udarov, I. T. Bulychev, A. G. Mrykin, and other specialists involved with new technology and production.

The secretary of the commission was a leading engineer from one of the main administrations, Aleksandr Aleksandrovich. As directed by the leadership of the commission, he led all the protocol and organizational activity and performed other tasks associated with the day-to-day functions of the commission. The young engineer, who had served on the front, was attracted to the practical and, particularly, the experimental work. In 1955-56, as the chairman of the working commission, he

V. M. Ryabikov (1907-1974), chairman of the State Commission for the first artificial Earth satellite

was already participating in tests of a number of systems. The results of the tests were used in the creation of the Soviet (and world's first) intercontinental ballistic missile—Korolev's famous "No. 7," which, as we all know, became the main booster for the satellites. The profound knowledge, initiative, and efficiency of the secretary of the State Commission did not go unheeded by the leadership. At one point during a report by Aleksandrovich on the accomplishment of a routine assignment, Korolev whispered to Ryabikov, "It'll probably make sense." With Korolev, who was stingy with praise, that was high appreciation! And the Chief Designer was not wrong. Subsequently, Aleksandr Aleksandrovich successfully managed major scientific-experimental organizations, was named Hero of Socialist Labor and awarded the Lenin Prize and the State Prize, and himself headed state commissions for many space-program complexes.

Between October 1957 and December 1965—that is, during Korolev's lifetime—the Soviet Union launched 124 spacecraft with various scientific and applied missions into near-Earth and interplanetary orbits. Chief Designer S. P. Korolev (1906-1966) was the technical director of many launches. His prescience is worth emphasizing: the artificial celestial bodies created under his direction during the first years of the space age not only accomplished their missions, but also laid the "orbital foundation" of the principal directions taken in the study and development of space, the growth of which continues even now. The 3 November 1957 launch with

the dog Laika aboard, for example, signaled the beginning of extraterrestrial biological research. Those first results made it possible to give a positive answer to the question, "Is it at all possible for man to fly in space?" And now months-long stints aboard long-term orbital space complexes—such as the newest of them, Mir—have become entirely routine. Our first Lunas, Veneras, and Marses opened interplanetary routes that many unmanned "researchers" of deep space, the planets, and the comets of the solar system have already traversed. Our third satellite, launched into near-Earth orbit in 1958, was, in essence, the first scientific laboratory in space, initiating the systematic, long-term program of research of near-Earth space performed with the Cosmos series of satellites. The sequence of numbers designating the newest satellites in the series reached the four-digit level long ago.

The chairman of the State Commission for the launch of the first such satellite was the experienced rocket-builder, V. I. Voznyuk (1906-1976). During the war, he commanded units [chasti] and combined units [soyedineniya] of the famous "katushas." In 1946, Voznyuk was named director of the first Soviet rocket range, at Kapustin Yar, which he successfully headed for three decades, to the last day of his fine military and working life. The flight-design [letno-konstruktorskiye] tests of the first Soviet long-range ballistic missiles, developed under the direction of S. P. Korolev, were performed at that rocket range in the late 1940s and early 1950s; and the "products" made by the design bureau of M. K. Yangel were tested there in the 1960s. Then Kapustin Yar also became the launch complex for spacecraft with scientific and applied missions. The services Voznyuk performed in the development of rocket and space technology were noted when he was awarded the gold medal of the Hero of Socialist Labor and the medal for laureates of the Lenin Prize. The State Commission headed by Voznyuk for the launch of the first Kosmos satellite included scientists and leading technology developers. Some of them later became well-known designers and scientists. Lenin Prize winner USSR Academy of Sciences Corresponding Member V. M. Kovtunenko, for example, directs a group of designers and developers who create unmanned interplanetary vehicles such as the famous Vegas, which, in heliocentric orbit, traversed 1.2 billion kilometers and went to a precision encounter with Halley's Comet. The launch of the first Kosmos was important not only in and of itself, as having initiated an extremely populous and "hard-working" dynasty of space vehicles. A new, two-stage booster rocket that was called Kosmos was being tested at the same time. It was developed under the direction of chief designer academician M. K. Yangel and became a series "product" that substantially cut costs for the Kosmos program as a whole. Many hundreds of scientific satellites were placed in near-Earth orbit with that booster.

The "type" of work performed by a spacecraft in orbit dictates the departments and organizations from which leading specialists are appointed to the commissions for the launch: relay satellites require specialists from the USSR Ministry of Communications; weather satellites, the State Commission for Hydrometeorology and Environmental Control; spacecraft with animals on board, the Institute of Medical and Biological Problems of the USSR Ministry of Health, and so forth.

V. I. Voznyuk (1906-1976), director of the first Soviet cosmodrome, from 1946 to 1976

Many rocket and space systems have been given their start in life by the State Commissions, which have been headed over the years by Lenin Prize winners A. I. Sokolov, M. G. Grigoryev, A. G. Mrykin, G. S. Narimanov, and V. I. Shcheulov and other specialists highly skilled in the field of new technology.

The length of time a State Commission is involved with the launch of a given spacecraft depends on the complexity and length of preparation and performance of the research program. The flights of unmanned interplanetary vehicles last many months or years, whereas Kosmos-1445 required less than three hours to perform its mission—which, of course, does not mean that the State Commission worked with that Kosmos for just three hours. The preparation of each spacecraft, its launch, and the processing of its findings requires complex, comparatively lengthy work by the State Commission.

And yet, regardless of how important the work of the State Commission is in handling unmanned space experiments, it would not be an exaggeration to say that it

bears no comparison with the complexities and the immense responsibility that the State Commissions have taken on themselves and continue to take on themselves in preparing and placing people into space—especially the first cosmonauts. After all, we are speaking here first and foremost about safety—about the health and very life of an individual in the extreme conditions of an environment that has not yet been fully studied. That, in turn, has placed additional requirements on the reliability of rocket and space equipment and ground facilities. Fundamentally new systems have had to be created: parachutes systems, for example, and radio communications with the spacecraft crews and telemetry monitoring and television observation from Earth of conditions aboard the spacecraft, as well as spacesuits, ejection seats that are custom-designed to fit each cosmonaut, and, moreover, special food in special packaging. The scientific research institutes, design bureaus, and plants where all this is developed and produced have expanded their collaboration with the enterprises that support manned flights to a much greater degree than with those that support unmanned flights. In addition to coordinating all this activity during the preparation and performance of the first manned Vostok flights, the State Commission set up flight-design tests that used animals and dummies aboard the satellite vehicles that had been developed. Between May 1960 and March 1961, five such spacecraft were launched into space. Analysis of the findings of those flights enabled the State Commission to make the decision to launch the first manned craft.

The State Commission approved the main pilot-cosmonaut and the reserve (the word "back-up" [Russian: dubler] did not yet exist in space terminology) and the flight program and work program in orbit; it supervised the preparation of the booster rocket, the spacecraft, and the cosmodrome for launch and monitored their readiness; it supervised the preparation of the measurement-and-control and search-and-rescue complexes and monitored their readiness for flight control and meeting the cosmonaut when the flight was completed. Konstantin Nikolayevich Rudnev (1911-1980) headed the State Commission. With multifaceted skills and rich experience, he made a grand contribution to the growth of our industry, the strengthening of the defense capabilities of the country, and the development of rocket and space technology. For his service to the Motherland, he was honored with the gold medal of the Hero of Socialist Labor, six Orders of Lenin, and other awards.

It was to him, Rudnev, that Yuriy Gagarin reported his readiness at Baikonur, on 12 April 1961, for that historic launch into space! Then came the new—the first in history—group-vessel flights and man walking in space. The technology and the work programs in orbit became more complex. There was increased concern in the State Commission, which was headed for several years by Doctor of Technical Science Georgiy Aleksandrovich Tyulin, Hero of Socialist Labor and Lenin Prize winner, now a professor at MGU imeni M. V. Lomonosov and an Honored Leader of Science and Technology of the

K. N. Rudnev, chairman of the State Commission for the launch of the Vostok-1, which had Yuriy Gagarin aboard, and A. I. Sokolov (left)

RSFSR. Tyulin's biography is, perhaps, the epitome of a "rocket and space" biography. Even before the war, when Tyulin was a student, he combined his studies with work in one of the mechanics and mathematics laboratories [laboratorii mekhmata]. There, in a wind tunnel, the staff of the department of rockets, which Korolev headed in the Scientific Research Rocket Institute, tested its "products." That was when Tyulin first saw the future Chief Designer.

Their second meeting—after which they, one might say, never parted until the last days of Korolev's life—took place after Tyulin returned from the front, where he had commanded a subunit and later became chief of staff of a group of the famous "katushas." In 1945, along with Korolev, Glushko, Pilyugin, Sokolov, Kerimov, and other rocket specialists, Tyulin was in Germany. There they familiarized themselves with the missile center in Peenemunde and the underground Dora plant, where the notorious "revenge weapon" of the Third Reich—the V-1 buzz bomb—and the V-2 ballistic missile were developed. Between 1947 and 1959, Tyulin was involved in the flight-design testing of the first Soviet long-range ballistic missiles at the Kapustin Yar rocket range and also in the creation of the measurement and control complex and the first group of scientific research vessels of the Zvezdnaya Flotilla.

In heading the State Commission, Tyulin, with his characteristic efficiency and competence, solved problems that came before the commission or that were related to the collaboration between enterprises in the course of the preparation and performance of the manned flights of Vostok-5 and Vostok-6, on which V. F. Bykovskiy and the first woman cosmonaut, V. V. Tereshkova, completed a multiday group-vessel flight. Under the direction of the State Commission headed by Tyulin, flights of the second generation of spacecraft were prepared for and completed—the Voskhod-1, with the first-ever three-man crew (V. M. Komarov was the

commander), and Voskhod-2 (commanded by P. I. Belyayev), from which the first walk into open space was performed. Those were the last manned flights while Korolev was still alive, and Tyulin headed the last State Commission that had been appointed and had worked when the Chief Designer was still alive. That State Commission performed some exceptionally complex tasks and made some extremely crucial decisions that were bold for that time, even taking a certain amount of risk, which was, of course, thoroughly thought out and, therefore, justified. Here is an example, as G. A. Tyulin recalls:

"On 12 June 1963, V. Bykovskiy took his place in the cabin of the Vostok-5 spacecraft at the designated time. The prelaunch checks of the craft and the preparation of the booster began. Suddenly we got a signal from the "Sun Service' that elevated activity on the sun had been recorded. So I ask, 'What does that mean?' They say, 'We recommend postponing the launch for 24 hours.' I think the members of the commission at the time were even less knowledgeable about the subtleties of that solar phenomenon. They conferred and decided to postpone the launch. The command is given: 'Stop operations. Bring the cosmonaut down.'

"On the next day, history repeated itself.

"On 14 June, with the solar activity, as it were, 'under control,' Bykovskiy again took his place in the spacecraft. But the vicissitudes did not end with that. After the rocket had already been fueled, a malfunction was discovered in one of the most important flight control systems of the booster—in the gyroscopic-instrumentation unit. The State Commission gathered for an emergency meeting. The reports of the technical director S. P. Korolev and the chief designer of the gyroscopes are heard. A decision is reached: replace the unit and make independent and then general tests of the entire booster rocket. But to do that would take time, and not that much time was allocated for prelaunch preparations. The nervousness was growing, although everyone tried to hide it from one another. One of the high-ranking directors who had come for the launch came to me with the suggestion that we postpone the launch for another 24 hours. The reasons for this, I admit, were both technical and purely human: how would all this up-and-down business affect the efficiency of the cosmonaut?

"The chairman of the commission must assume all the responsibility in such situations. After repeatedly weighing all the pros and cons, and after consulting with Korolev and Keldysh, I make the decision to continue the preparations for launch and to not postpone it. At the regular meeting, the State Commission supported my proposal. As a result, instead of the two hours allotted in the program, the prelaunch preparations continued for a whole six hours. Here the self-control, endurance, and calmness of Valeriy Bykovskiy must be given its due. It seems, he did not even display any concern over the reasons for the delays, and his reports resounded loud and clear over the radio." Or another example. Chayka (V. V. Tereshkova's call sign) was not feeling so well on the first few orbits. The commission was even discussing the possibility of ending the flight of Vostok-6 ahead of schedule. The chairman of the commission talked it over with Tereshkova by radio. She asked that the flight not be interrupted, said that she already felt better (that was later verified with the telemetry data), and assured the State Commission that she would carry out "everything that the program called for" and would do "everything as we were taught."

Baykonur cosmodrome, 18 March 1963. The crew commander of the Voskhod-2, P. I. Belyayev, reports the crew's readiness for the flight to G. A. Tyulin (center), chairman of the State Commission. S. P. Korolev is on the extreme left.

The second generation of spacecraft, the Voskhods—whose crews did not eject before landing, as did their predecessors on the Vostoks—gave rise to no small amount of concern among the commission and the technical directors. The crews landed seated at their work positions in hermetically sealed descent vehicles that were the first to be equipped with a soft-landing system. The crew of the first Voskhod flew in space without even the benefit of a spacesuit—they wore regular, wool, "terrestrial" training outfits. P. I. Belyayev and A. A. Leonov, however, had spacesuits, but they had an extraordinarily complex mission ahead of them: Leonov was to walk in space, and Belyayev was to be in command of this unprecedented operation, which was not without danger. It should also be added that, because of malfunctions, the commander was the first to have to land his spacecraft, Voskhod-2, manually. Deciding on this was not easy for the crew, the controllers, the Chief Designer, or, finally, the chairman of the State Commission. But a decision to make a manual landing had to be made in minutes! That is why Korolev was more than justified in saying that that commission had faced harder tasks than any before it. A donated inscription made by Korolev on the back of a photograph (see photograph of 18 March 1963, at Baikonur) testifies to that: "Dear Georgiy Aleksandrovich Tyulin, 'Chairman of the Toughest Commission,' in memory of our already traditional meetings, those nervous, unforgettable meetings

that were filled with so much meaning and were a necessary prologue to the routine voyage into space. S. Korolev. 10 October 1964. 'Voskhod.'"

The first "Korolevian" decade of the space age was drawing to an end. Those were the years of great achievements, the springtime of the space program, when the epithets "First in history," "First in the world" were rightfully appended to each routine Soviet spaceflight!

The steady expansion of space research and international cooperation in this area, the development of state-of-the-art ground-based and rocket and space equipment, the increased demands for testing such equipment, and much more—all this has increased the responsibility and expanded the nature of the activity of the State Commission, which now focuses its attention primarily on the preparation and performance of the flight-design tests themselves. Here is what Hero of Socialist Labor Lt.-Gen. Kerim Aliyevich Kerimov, who for more than two decades has headed state commissions for flight-design testing of manned scientific research complexes and a number of unmanned interplanetary spacecraft, has to say:

"The commission examines and approves, upon presentation by the technical directorship, the flight programs of manned space complexes and unmanned interplanetary spacecraft, as well as the programs for the scientific and applied research and experiments in near-Earth and interplanetary orbit, in behalf of science, economics, and society. The results of these ventures are being used at present by hundreds of institutes of the USSR Academy of Sciences and other organizations. The State Commission analyzes the results of plant and bench tests of the booster, the spacecraft, and the space stations themselves and decides whether they should be released to flight testing. The commission approves the main crews and back-up crews, directs the preparation and launch of space complexes at Baikonur, and controls their flight, docking, redocking, and landing. The commission must know—and does know!—everything about the readiness to support routine space flight on the part of the cosmodrome; the measurement and control complex, whose tracking stations operate both within the borders of our country and in the World Ocean; the Flight Control Center; and the main operational group involved with flight control and the combined search-and-rescue complex. The commission must make decisions that involve program changes and unforeseen situations, even if it means cutting a flight short and landing the crew in the predetermined region of the country or in a newly designated region not specified in the program.

"Unlike other state commissions that issue approval for new structures or, say, for aircraft or missiles, our State Commission "steers" a space complex from the beginning of its development all the way to the return of the descent vehicle to Earth.

During a meeting of the State Commission. From left to right: Academician M. V. Keldysh, Chairman of the State Commission Lt. Gen. K. A. Kerimov, and Academician V. P. Mishin.

"In a word, with the expanding range of space research and the creation for it of ever more complex and numerous rocket and space, ground-based, and marine complexes and airborne facilities, the volume of critical work done by the State Commission grows steadily, as does its responsibility for the reliability and irreproachable conduct of flights into the Universe." And who in the world is the individual who has, for more than two decades now, headed a State Commission that is unique in its own right, and how did he get into the space program, with which he is totally absorbed in his free time from the commission? Those are not rhetorical questions. The readers of our journal, after all, have before now known nothing of the chairman of the commission, save perhaps his voice, "for the staff," in the radio and television reports from Baikonur, when K. A. Kerimov wishes the next crew "a successful flight and a safe return to Mother Earth."

"I was born on 19 November 1917, in Baku," says Kerim Aliyevich, "where I finished middle school and then the Azerbaijan Industrial Institute. In early 1942, I entered the Military Artillery Academy imeni F. E. Dzerzhinskiy at the fifth-year level. I finished it with a military engineer-artilleryman diploma. My activities in the radio club at the Baku Children's Technical Station, my studies at the institute in electromechanics, and, of course, the military disciplines that I studied at the academy have all contributed to my specialty. From 1943 to 1965, I worked in the USSR Ministry of Defense.

"I became chairman of the State Commission for Soyuz spacecraft 22 years ago. Beginning in 1946, I worked with Korolev in various stages of the development of rocket and space technology. That is when our comradely relations began. They were close but not idyllic. There were disputes, and arguments. At that time, Korolev was working to develop a ballistic missile, and I

represented the client side. From the very beginning, we armed ourselves with the motto 'Nothing's trivial in our work!' And that's our credo today, too.

"In rocket and space technology, we feel that accuracy, reliability, and discipline are a must. Here, they say, God himself told us to work that way. The principle of state acceptance, which is now being introduced into industry, has, in fact, been operating in our work since the very beginning.

"As for my so-called earthly interests, it turns out that they are all tightly interwoven with what is being done in space. But I've been active in sports my whole life, especially in swimming. I also watch soccer matches, if rarely, but I can't call myself an avid fan. I love literature. But, I repeat, my thoughts are almost always with those who are in orbit."

On 7 June 1988, the chairman of the State Commission gave the "green light" to an international Soviet-Bulgarian crew aboard the Soyuz TM-5 spacecraft, a crew that consisted of A. Solovyev, V. Savinykh, and the Bulgarian A. Aleksandrov.

The time will come when, at a Soviet cosmodrome, those long familiar words, along with absolutely new ones, will ring out: "Comrade chairman of the State Commission! The crew of the interplanetary vessel for the flight to Mars is ready!"

Kerimov Interviewed on Role of State Commission
18660240 Moscow SOVETY NARODNYKH DEPUTATOV in Russian No 4, Apr 88 pp 50-53

[Interview by SOVETY NARODNYKH DEPUTATOV correspondent with K. A. Kerimov, State Commission chairman, under the rubric "Living History, Noteworthy Events": "Rockets Go Into Space"]

[Text]Question: Kerim Aliyevich, for a long time you've been one of the specialists who are considered "restricted." My TV journalist colleagues, reporting from the Baykonur Spaceport or from the Moscow airport at which cosmonauts who have completed their missions arrive, you recall, took special care that the person to whom the crew made its report—the State Commission chairman—would not be in the picture. Recently, it has become possible to expand the frames of the picture, and millions of viewers could see you. Our readers would like to get better acquainted with you, to know more about your biography. Especially because, according to tradition, we celebrate Cosmonaut's Day in April.

Answer: Artillery led me to space. But first I graduated from the Industrial Institute in Baku. That was during the war, and I was quickly recommended for the Artillery Academy. I gladly agreed. The Academy was in Samarkand, to which it had been evacuated from Moscow. I was immediately accepted into the fifth year, into the faculty which trains specialists in rocket weaponry, or, more simply put, in "katushas." By that time the Fascists had already been destroyed at Stalingrad, and we were given another whole month for our senior project. We defended the project, passed the state examinations, and received the degree of military engineer. I was sent to serve as a military representative at a plant that produced rockets. Immediately after the war, I was recommended for transfer to the USSR Ministry of Defense's Main Artillery Directorate. I began with the lowest position of senior engineer. In 20 years I made it to chief of the directorate. I studied missiles there. In 1965, I was appointed chairman of the State Commission.

Question: We've come to the main topic of our conversation: the State Commission's activities. Journalists covering space flights have had occasion to attend its meetings. There, at Baykonur, we heard brief reports from specialists who had prepared the next space mission and the words, "The State Commission has decided..." The crews—main and backup—launch time, and other pre-launch information were announced. This was the result a great deal of extremely laborious, painstaking work, the specific content of which one can only guess. In what did it consist? What role does the commission play in preparing for a space flight?

Answer: Let me immediately note that our commission is involved not only in preparing for a flight, but also in expediting the entire program of space missions. Admittedly, at first, in 1965, we had a specific task of testing the new space complex that would replace the Vostok and Voskhod spacecraft. The complex already had a name, the Soyuz, and the commission had been given the title "State Commission for Flight Testing of the Soyuz Spacecraft." As everyone knows, this work was completed. A spacecraft was developed with new capabilities and greater comfort for cosmonauts. Unlike the first ships, which had not been designed for long flights and consisted only of a descent vehicle and an instrument compartment, the Soyuz has an additional living compartment where one can rest. Remember that until the Salyut was developed, a craft acted as a habitable orbital station performing a wide variety of tasks in near-Earth space. As you know, the Soyuz still exists, admittedly after two modifications which have expanded its capabilities.

When does the testing usually end? When the new craft is accepted for operation. One must be sure that it suits it purpose, that everything has been properly done—that's where one's functions end. The rest is up to those for whom the vehicle was developed.

It's different for us. After the completion of tests, the Soyuz stayed "in our hands." We were assigned to oversee its operation and, when the Salyut and Mir were developed, their operation as well.

Question: You mean the scope of your job expanded?

Answer: Yes, we changed from a testing commission into a commission which facilitates all a complex's work.

What are we involved in now? The third permanent mission is now at work aboard the Mir station. Like the previous one, which Yu. Romanenko commanded, it's spending a long time in space. How long? Careful study of the results of the first two missions on the Mir station will provide the answer. After analyzing them and making sure that all comments and suggestions have been considered, we'll make the appropriate adjustments to V. Titov and M. Manarov's flight program. That is one task we're involved with.

The second is to summarize the results of the scientific experiments performed by Yu. Romanenko's crew during almost a year of flight. We will carefully look at whether everything was properly prepared and carried out and at what the results were, including the economic effects. We believe that everything should be put in terms of rubles as well...

Question: Really! Have you being doing this kind of accounting long?

Answer: Restructuring affects us, too. It should not be that everyone else reckons the economic impact, while space remains on the sidelines. When we gave specialists the task of preparing a thorough report on the results of Yu. Romanenko's mission, we particularly noted that it should be done with regard for the new trends, particularly self-support.

Question: You believe that this principle can be adapted to space, too?

Answer: Of course we're a long, long way from self-support, but some aspects of it must be introduced now. Of course, not everything lends itself to accounting. For instance, the study of the stars, nebulae, and other astrophysical phenomena can hardly be translated into rubles, although sometimes this apparently has a practical benefit. You have expenditures for research conducted from space in the interests of agriculture and the fishing industry, geology, and meteorology, and their returns can already be calculated today. Those who have made use of those benefits should settle up for them.

One of the commission's important tasks is to evaluate the results of the research involving man's protracted stay in space. A great deal has recently been said about the goals of this research. I'm speaking of man's study of the Solar System with long missions. We primarily have in mind flights to Mars, and not everything on the Moon has been studied yet. We must identify conditions which will enable man to tolerate the schedule for these missions. Yu. Romanenko spent about a year in orbit and feels all right. Data from medical and biological examinations confirm this. As you know, it is a matter not just of the unique features of the cosmonaut's body, but primarily of the set of measures selected by flight theory and practice. This includes physical training, medical support, mental relief, and, finally, comfort and nutrition. Does this mean that we're can already provide the conditions for man work and live in space for prolong periods? No, if only because the trip from Earth to Mars and back will take 2.5-3 years. It's not out of the question that circumstances which did not manifest themselves in 11 months could have an adverse effect on the body if this period is tripled. Noise, for example. A station, after all, has a great deal of equipment in which something must turn or move, and that means noise. Specialists believe that this can have an adverse effect on the body. We must think of ways to suppress noise. A more complicated problem is weightlessness. I'm thinking of the creation of artificial gravity inside the ship. Many are convinced that only this will enable successful solution of the problem of man's prolonged stay in outer space. Experiments will show whether they are right.

Question: What about the technical feasibility of a flight to Mars? One might imagine how huge a ship or complex would have to be to deliver a mission to Mars and bring it back. How do you propose to launch such a vehicle?

Answer: Indeed, the mass of the interplanetary complex will be substantially different from that of the spacecraft that are being developed for orbit today. Docked, the Mir-Progress-Kvant-Soyuz has a mass of about 50 tons, while an 800-ton structure must be sent to Mars. The launch of the Energiya booster rocket last year proved that we can assemble such a "train" with 7-8 dockings in orbit and then send it to Mars. By the way, the other technical details of the flight are also quite solvable, and the flight could take place by the beginning of the next century.

Question: Then in theory, the Soviet Union can organize such a mission independently?

Answer: Only "in theory." We still haven't touched on the economic side of this undertaking. The space mission will require "space-sized" expenditures. Specialists cite various figures, but even a rich country can hardly allocate even the most modest fraction of the amount needed for these purposes. And even if it could, what would be the point? The information obtained is needed not just by one country, but by all mankind. In a word, it makes sense to combine the efforts of different countries to achieve this goal. By the way, if each participant would toss into the pot that in which he has achieved scientific and technical superiority, then the costs for the mission could be lower than those that have been hypothesized.

But this is where the stumbling block lies. Fear of losing primacy in any area of science and technology and, most important, the income it will yield compels capitalist countries to approach the idea of cooperation in space with extreme caution. Military affairs also have their

role. However, thanks to our country's efforts, the international climate is becoming warmer, and problems involving the reduction of nuclear arsenals are being solved. I hope that this will benefit international space projects as well.

Let us return, however, to the topic of our conversation. The commission reviews and approves the program for the upcoming flight. After this we evaluate the reliability of the entire complex. Different organizations, including scientific organizations in the departmental system and the USSR Academy of Sciences, prepare conclusions for us. If there are comments about the complex's level of development and reliability, we make sure that they have been taken into account. This sometimes takes a great deal of time. We must carry out painstaking work to eliminate shortcomings or to find the reason for differences of opinion and resolve them. Only when all organizations participating in the preparation for the mission are completely agreed do we give the go-ahead for the launch. Decision-making by majority rule is not permitted.

Question: But this can affect the launch schedules for space vehicles. Before, when they were not announced, it was probably simpler. Now they are reported ahead of time. What would happen if you didn't manage to do everything before the deadline?

Answer: We would postpone it. I don't see anything to be embarrassed about. Work is work. Before, the reason for not announcing launch time was not because this allowed us to postpone it without anyone noticing. Much of this was determined by the extraordinary nature of the work. Launching a spacecraft isn't the same as flying an airplane from Moscow to Leningrad. Each time it was like solving a complicated problem with many unknowns, and "flight schedules," especially in the early years, were considered irrelevant. Much has happened now, and we can more or less accurately plan specific deadlines. Although, I repeat, they can also be postponed.

After launch, the next phase in the commission's work begins. We oversee the working group which supports a mission's flight at the Flight Control Center. The group includes specialists who prepared the mission's program. This is as it should be: they developed the documentation, and they are the ones who work from it. Every day at 8 am they report to me—and through me to the State Commission—on how the flight program is progressing. These reports usually don't require that the commission be convened. Fortunately, it's rather rare that everyone must be hurriedly assembled.

Question: You don't remember when the last time was?

Answer: Almost a year ago. You probably even remember the story of the Kvant module.

Question: Yes, of course. At that time, we waited impatiently at the Flight Control Center for reports on the first scientific module's docking with the Mir station. We waited not just that day, but the next several days. I remember some of the headlines that reflected our mood at the time, such as "First Attempt" and "There are No Simple Tasks."

Answer: There was good cause for that mood. At first, because of an unforeseen situation, we had to halt the crafts' rendezvous in the final phase. Then, when docking had already begun and the specialists reported, "There is contact," it turned out that the final operation—mechanical linkup—was not working out. For some reason, it was impossible to get past just a few dozen millimeters. And this meant that there was no electrical contact between the vehicles, no pressurized seal...In a few words, the long-awaited Kvant could not be used for what it was designed to do, and they couldn't get over to it and work. What to do? The commission discussed this question each day. We gathered at 9 PM and examined all the attempts to save the situation that had been made in the previous 24 hours, evaluated them, and suggested new ways. Finally, we decided to allow the cosmonauts to go out into open space. We had the impression that something on the outside was interfering. And, indeed, the cosmonauts discovered a foreign object in Mir's docking assembly.

Question: What on earth was it? The report was that it was some kind of fabric that the cosmonauts, in reaching for something, had cut with a knife, and that it was difficult to identify its origin.

Answer: We also were puzzled and had different hypotheses. But it turned out that the cosmonauts reported that they couldn't recognize the object. Then, after they had already returned to Earth, they said that it was a kapron [Soviet-made nylon] bag with...wastes. It somehow got into the crawlway connecting the Mir and the Progress. When the cargo ship was being prepared for departure and the cosmonauts closed the hatch, they hadn't noticed the package, and it remained outside on the docking assembly...

Question: Kerim Aliyevich, looking to the future, how do you see the space program evolving?

Answer: First and foremost, there will be the clear division outlined today between the near-space program and the deep-space program. The first will serve man's terrestrial concerns: It will help him better develop the planet and obtain materials with valuable properties which can be produced only in space. It may be possible to create orbiting devices which could give timely warning of natural disasters and even prevent them.

The deep-space program will also be divided. One area will involve the study of the Universe, the history of its evolution, and the prospects for the use of this knowledge. Quite extraordinary research methods and devices

will be created for this. The task of the other area will involve man's exploitation of the Solar System. People will be engaged in the search for new places to inhabit and the development of planets not yet suitable for life, such as the Moon, Mars, and Venus. In general, our successors will have plenty of work.

Career of Space-Launch Complex Designer V.P. Barmin

18660062 Moscow KRASNAYA ZVEZDA in Russian 22 Oct 88 p 3

[Article by M. Rebrov, Colonel]

[Abstract] The full-page article salutes the work of Vladimir Petrovich Barmin, general designer of space launch complexes and a laureate of the Lenin and USSR State Prizes.

It is recalled that Barmin graduated from the Moscow Higher Technical School in 1930, with the specialty of mechanical engineer. He became a member of a group which was sent to the United States on a business trip. (It is mentioned that most of the other members of this group were subsequently arrested and that Barmin was once summoned to the People's Commissariat for Internal Affairs for questioning about his former associates.) After returning to the USSR, Barmin became a design engineer in the compressor department of the "Kotloapparat" plant, which was subsequently renamed the "Kompressor" plant. He was appointed a chief designer of this plant in February of 1941. Shortly after Germany invaded the USSR, Barmin was assigned to work on drawing up production plans and specifications for the BM-13 mobile rocket launcher. A.G. Kostikov, an engineer, was chief designer for this project. Barmin went on to become chief designer of the special design bureau at "Kompressor" which worked on the BM-13 and other mobile launchers.

A conversation is recorded in which Barmin recalled postwar work on launching platforms for the USSR's first long-range missiles and on a launch complex for the country's first intercontinental ballistic missile. The designer also related that he once supported construction of the Plesetsk space-launch complex in opposition to N.S. Khrushchev, at a high-level meeting. Launching structures for the first space rockets were developed by Barmin and his colleagues in contact with Sergey Pavlovich Korolev. A group headed by Barmin took part in development of launch complexes at the Baykonur and Kapustin Yar cosmodromes as well as Plesetsk. The designer mentioned launches of "Vostok," "Soyuz," "Proton" and "Energiya" rockets as some of the most memorable which he has witnessed, and he praised results of the initial tests of the "Energiya."

Agreement Signed on USSR-Austria Space Mission

18660063 Moscow PRAVDA in Russian 12 Oct 88 p 4

[Excerpts] Talks between N. I. Ryzhkov, chairman of the USSR Council of Ministers, and F. Vranitzky, Federal Chancellor of the Republic of Austria, who is in the Soviet Union on an official visit, took place in the Kremlin on 10-11 October.

Questions of the further development of Soviet Austrian cooperation and main problems of international affairs were discussed in a constructive and friendly atmosphere.

N. I. Ryzhkov and F. Vranitzky signed an agreement between the USSR and Austria on conducting a joint Soviet-Austrian space mission.

This document vividly reflects the spirit of the times and signifies a new stage in the development of relations between the two countries.

Meeting in Moscow on Soviet Participation in Australian Spaceport Project

18660057 Moscow VECHERNYAYA MOSKVA in Russian 17 Nov 88 p 1

[Article by D. Gay (interviewer)]

[Excerpt] Creation of an international spaceport in Australia is by no means sheer fantasy.

A group of Australian specialists arrived in Moscow by air today for a thorough discussion of this project with colleagues of the Main Administration for Development and Use of Space Technology for the Economy and Scientific Research (Glavkosmos).

A VECHERNYAYA MOSKVA correspondent talked with Vyacheslav Ivanovich Dukov, deputy head of USSR Glavkosmos.

"Some time ago, during a visit to the USSR by the prime minister of Australia, an agreement in the field of space exploration was signed between our states. After that, it was proposed that the Soviet side take part in construction of an international spaceport on Cape York for launching satellites on a commercial basis.

"Cape York's proximity to the equator makes it possible to increase substantially, up to 45 percent, the payload capacity of launch-rockets in placing satellites into orbit. Moreover, climatic conditions are excellent at this site, and it is remote from population centers, which means increased safety of launches.

"An international conference, 'Commercial Possibilities of Space Transport Systems and Related Branches of Industry,' was held in the Australian city of Brisbane in April of this year. Delegations from countries which are

leaders in the field of space exploration, including the USSR, took part in this conference. I had the opportunity to be a member of our delegation and give a paper.

"It was at this conference that plans for creating an international spaceport on Cape York were discussed.

"The spaceport could include several launching areas for different kinds of launch-rockets, such as the USSR's 'Soyuz' and 'Proton.' Also envisaged are aerospace systems with horizontal takeoff, for ultrahigh-speed transportation of passengers and all kinds of cargo from Australia to Europe. Realistic prospects exist for employment of reusable spaceships of the 'Shuttle' and 'Buran' types."

Ionospheric Research, Satellite Tracking Suggested as Uses for Krasnoyarsk Radar Facility

18660060 Moscow PRAVDA in Russian 8 Nov 88 p 6

[Article by N. Krivomazov, V. Ovcharov, Yu. Khots, correspondents (Krasnoyarsk)]

[Text] The article recounts a visit to the site of the Krasnoyarsk Radar Station. Construction of this station was halted a year ago in response to Western protests that the project violated the terms of the Missile Defense Treaty.

At the construction site, the authors of the article were accompanied by Boris Vasilyevich Shishkin, a 55-year-old representative of the USSR Ministry of the Radio Industry, who explained the purposes for which the station was intended. As the number of artificial Earth satellites and other spacecraft in continuous operation approaches 10,00, special facilities are needed for monitoring these objects, Shishkin pointed out. The Krasnoyarsk station was supposed to employ a fundamentally new system for tracking a large number of spacecraft. The station was sited in an area over which the flight paths of many spacecraft pass.

A transmitting installation, a receiving installation and an engineering support complex reportedly have been built at the construction site. The station's transmitting and receiving antenna arrays are said to be 30 x 40 meters and 80 x 80 meters in size, respectively. The latter array is intended for receiving signals reflected from spacecraft, as well as signals from extraterrestrial sources of radio-frequency radiation. Shishkin emphasized that the station's features make it unsuitable for missile defense purposes. The station operates in the metric wave band and receives its power from an ordinary supply system, for example. Moreover, the station could not survive a nuclear attack because its buildings have no special protection and lack the necessary safety factor.

Since the construction project was shut down, the station has been transferred to the jurisdiction of the USSR Academy of Sciences, and M.S. Gorbachev has proposed that a center of international cooperation for peaceful use of outer space be set up on the basis of the station's facilities, it is recalled. Shishkin thought that the station's facilities could be used for ionosphere studies in support of satellite tracking and satellite-aided communications, for example. He noted that the station's orientation and the wave band in which it operates would allow research of a huge volume of near-Earth space to be carried on there.

Two photographs are given showing buildings and the transmitting installation of the station.

Delay in Launch of 'Cosmos-1870' Satellite Ascribed to 'Intrigue'

18660065 Moscow PRAVDA in Russian 5 Oct 88 p 3

[Article by V. Etkin, Professor, head of the Department of applied Space Physics of the USSR Academy of Sciences' Institute of Space Research, State Prize laureate]

[Excerpt] The artificial Earth satellite "Cosmos-1870" has been operating in orbit for more than a year. This satellite was launched by a "Proton" rocket on 25 July 1987. It is a heavy, new-generation satellite which is intended for observing the Earth. "Cosmos-1870" is equipped with specially designed radar which makes it possible to obtain high-resolution (10-30 meters) images of practically any part of the Earth's surface quickly and effectively in any kind of weather and at any time of the day.

The appearance of this satellite marks a qualitatively new stage in the advancement of space equipment for observing the Earth, particularly the condition of the world's oceans.

Images obtained with the "Cosmos-1870" satellite's radar and analysis of these images have demonstrated the possibility of determining from space a number of the "ocean—atmosphere" system's characteristics, particularly the density of wave caps on the sea's surface. This density depends on the average velocity of driving wind, which opens up the possibility of measuring it. It also becomes possible to inspect interaction between internal and surface waves, which is an important path of energy exchange in the "ocean—atmosphere" system..

It has been possible to detect also seamounts, submarine banks, shallows, etc., in radar images of the sea. Changes have been recorded in the density of water according to depth, which is determined chiefly by the temperature profile. The variability of currents and temperature fronts, the formation of eddy currents in the ocean, and the appearance and development of upward movements of deep waters can be monitored.

Results which have been obtained argue in favor of transferring to systematic and regular work on global monitoring of the "ocean—atmosphere" system, using a system of radar oceanographic satellites. But I would like to comment on still another topic here.

Soviet cosmonautics, like other fields of our work in the 1970s and early 1980s, was affected by forces of stagnation and retardation. The satellite which was given the name "Cosmos-1870" was ready for launching about seven years ago, but the launch was cancelled because of intrigues against the director of the satellite's development. Personnel of industry and the cosmodrome who preserved the satellite and its equipment intact, contrary to 'instructions,' should receive due credit for their courage.

Standardization of Spacecraft Equipment Discussed at International Conference

18660064 Moscow KOMSOMOLSKAYA PRAVDA in Russian 19 Oct 88 p 3

[Article by S. Leskov, correspondent (Sofia and Moscow)]

[Abstract] The article reports on results of an International Congress of the Association of Participants of Space Flights which was held recently in Sofia, Bulgaria.

Forty cosmonauts from 13 countries reportedly attended this conference. Topics of discussion included orbiting stations which are under development in the West, development of safety and rescue methods and equipment for crews of space shuttles and spaceships, prospects for international interplanetary missions, and the possibility of encounters with extraterrestrials. A paper given by B.V. Raushenbakh, member of the USSR Academy of Sciences and an honorary guest of the conference, dealt with space operations which inhabitants of the Earth might undertake for the purpose of monitoring ice-covered satellites of the planet Jupiter. The purpose of these operations would be to prevent explosions of satellites resulting from impacts of meteorites. Raushenbakh explained that large fragments of an exploded satellite which subsequently struck the Earth would produce catastrophic effects on our planet.

Factors which are impeding international cooperation among space explorers were the topic of much discussion at the congress, the author relates. It was pointed out in particular that practically no experience with space rescue missions exists in world cosmonautics as yet, and that communications, control and docking equipment of different countries' spacecraft have not been unified. Adoption of a joint letter on this problem was considered at the congress, but agreement could not be reached on the international or national agency or agencies to which it should be addressed. The USSR Main Administration for Development and Use of Space Technology for the Economy and Scientific Research does not consider such questions its responsibility, for example.

Plans for 'Interbol' Project in Early 1990s

18660061 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 10 Nov 88 p 4

[Excerpt] It is planned to launch two spacecraft early in the 1990s. Their destination will be nearby space. A Galeyev, corresponding member of the USSR Academy of Sciences and scientific head of the international project "Interbol," told about this project:

"Plasma cannot break through to the Earth because its magnetic field prevents this. Our planet is wrapped in a remarkable cocoon—the magnetosphere. It resembles a comet with a nucleus (our planet) at the center and a long tail behind it. It is to this tail that we intend to send one of the spacecraft.

"'Interbol' is the first contribution to implementing an extensive program. The USSR, 12 other countries and the European Space Agency are taking part in this project.

"Two satellites of the 'Prognoz' type will be sent into space first. The first of these spacecraft will fly to magnetic islands—the least-explored structures of the plasma layer. This satellite will find itself right in the thick of energy processes. It will cross the magnetosphere's tail at a distance of approximately 100,000 kilometers from Earth. The second satellite will patrol the oval-shaped area of the polar auroras at an altitude of 5,000-15,0000 kilometers.

"Each spacecraft will weigh approximately 800 kilograms. Small subsatellites produced by Czechoslovak specialists will separate from these spacecraft in orbit. Dynamics of electrophysical processes will be evaluated with the aid of these subsatellites, which will alternately approach to within several hundred meters of the main spacecraft and move hundreds of kilometers away from them.

"It is planned to use the instruments of still another satellite, 'Relikt-2,' for research of remote regions of the magnetic tail. This satellite will travel to a distance of 1.5 million kilometers from our planet and be located at the point of gravitational equilibrium between Earth and the sun. Our purpose in going to this distance is to understand how the evolution of plasma structures such as the magnetic islands ends.

"American and Japanese colleagues of ours will join the experiment later on. New spacecraft will set out into space. And then, with an extensive network of stations at our disposal, it will be possible to talk about constructing a fairly complete three-dimensional picture of space flows and movement of plasma in the magnetosphere."

Tolstykh Describes "Flight to Mars" Key Research Program

PM0901145589 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 1 Jan 89 p 1

[Interview with B. Tolstykh, deputy chairman of USSR Council of Ministers and chairman of the USSR State Committee for Science and Technology, by D. Pipko: "A Dream Embodied in Programs"—date, place not given; first paragraph is editorial introduction]

[Excerpt] "Flight to Mars," "Human Genome," "Safe AES," "Artificial Intelligence," "Automobile-2000"... Today these ideas no longer appear to be alien intruders from the pages of science fiction—they are the working titles of projects and areas within state scientific and technical programs. B. Tolstykh, deputy chairman of the USSR Council of Ministers and chairman of the USSR State Committee for Science and Technology, talks below about the role such programs are assigned in the new concept of the country's economic development and how they will be carried out.

[Tolstykh] In recent years life has repeatedly made us ponder: How is it that we have been left behind in many important scientific and technical areas?

Were there forecasts? Yes. Bold ideas ahead of their time? Our scientists, specialists, and inventors were unstinting here. So what was lacking? There was no system, no instrument to help to dynamically develop and implement these ideas. In the new concept of economic development discussed at our party Central Committee's November (1988) Plenum, state science and technology programs are to serve as such an instrument.

Figuratively speaking, they must help us look beyond the horizon. What will our grandchildren and great-grandchildren eat? Where will they live? In what will they fly and travel? What kind of illnesses will they suffer from? We need exhaustive answers to these and many other similar questions.

[Pipko] Boris Leontyevich, we have tried before to make use of the benefits of a targeted program approach to complex tasks. But with the possible exception of the nuclear and space problems, most of the programs did not live up to our hopes. Is it worth reverting to this form of work organization in the new management conditions?

[Tolstykh] It is not the form but the content that is at fault. In our pursuit of sheer quantity, we devalued the essence of programs: Many of the programs, though described as all-union, tackled purely sectorial tasks. Even then we should have measured ourselves against foreign experience. And we would have discovered that in the United States, for example, there are only 10 national programs. These include the SDI, a biomedical research program, including the fight against AIDS, and a so-called strategic computer initiative aimed at computerizing society. There are slightly more programs—14—in Japan. One of them is concerned with creating a 5th-generation computer, another, called "Sunlight," is aimed at developing and making extensive use of alternative energy sources.

Numerically we are on par with the Japanese: 14 scientific and technical programs aspire to "state" status at present. A number of them, such as "Human Genome," "High Energy Physics," or "High Temperature Superconductivity" are basically aimed at carrying out fundamental and applied research. Others, however, like "Latest Bioengineering Methods" or "Environmentally Clean Power Industry" programs envisage the creation of new technologies and even the the commissioning of turnkey projects. The "Future Information Technologies" program is concerned with computerization as the stage after the industrialization of society. Each program consists of several areas. But in terms of their content and the nature of the end results and intended expenditure they all widely differ from one another.

The "Mars" program, for example, envisages the development of a detailed engineering model of that planet and the study of the technical potential for a manned flight to Mars. According to specialists, such a flight could take place in the years 2015-2017 if the scientific potential of the USSR, the United States, and other developed countries is pooled. In short, the realization of this long-standing dream of mankind depends on the success of the policy of detente.

Career of A.A. Shumilin, Head of Cosmodrome Ground Testing Service

18660067 Moscow KRASNAYA ZVEZDA in Russian 3 Dec 88 p 3

[Article by V. Baberdin, Colonel (Baykonur and Moscow)]

[Abstract] The article comments on the work of the ground testing service at the Baykonur Cosmodrome and traces the career of Aleksey Aleksandrovich Shumilin, head of this service.

Shumilin has worked at the cosmodrome since March of 1959, it is recalled. He held the positions of test engineer, head of a department and deputy head of a laboratory before becoming head of the testing service. This service's duties include checking the functioning of systems of rockets during the final stage of preparations for each spacecraft launch. This stage begins with the assembling of the launch-rocket and joining of the spacecraft to the rocket in the cosmodrome's installation-and-testing complex. Checking continues up until the command to launch is given. Testers must be on the alert for critical situations which may develop at any point in the process.

Shumilin praised the service's handling of such a situation which occurred during the launching of a spaceship manned by Vladimir Titov and Gennadiy Strekalov, on 26 September 1983. Shumilin recalls that he was inside the firer's bunker during the final countdown at the launching site. With him were an industrial representative named Soldatenkov who duplicated Shumilin's actions; Kerim Aliyevich Kerimov, chairman of the state commission; and Yuriy Pavlovich Semenov, chief designer of "Soyuz" and "Progress" spacecraft. Shumilin was given a special code to use in the event of unforeseen circumstances. Through a periscope, he saw fire break out while a fuel line was being blown out with nitrogen. He pronounced the code words into a handset within a few seconds. Ejection of the spaceship's reentry vehicle was accomplished almost simultaneously by personnel who were on duty in the measuring complex for the emergency rescue system.

Soviet-French Space Science Missions Planned

18660068 Moscow IZVESTIYA in Russian 27 Nov 88 p 3

[Article by B. Konovalov, science commentator]

[Abstract] The article surveys current directions of Soviet-French work in the field of space technology. Nine joint space-research projects of the two countries reportedly are in progress at the present time.

Professor Yu. Galperin of the USSR Academy of Sciences' Institute of Space Research is quoted in regard to spacecraft launches which are planned in line with the international project "Interbol." Other projects in which France is taking part involve development of space observatories called "Gamma-1" and "Granat." A unique space gamma telescope which is called the largest of its kind reportedly has been developed by Soviet and French organizations under the direction of the Institute of Space Research and France's Nuclear Research Center in Saclay and Space Center in Toulouse. This instrument, which is said to surpass its predecessors with respect to angular resolution, will be installed on the spacecraft "Gamma-1." A special automatic module for the gamma telescope has been developed by Soviet designers on the basis of a "Progress" spaceship. This module will be equipped with gyrodynes for maintaining highly precise orientation toward objects under study. Three-dimensional gamma-ray images of celestial objects will be obtained with the aid of the "Gamma-1," is being developed on the basis of Soviet spacecraft of the 'Venera' series, the author relates. "Granat" is characterized as a successor to the satellite "Astron," which carried ultraviolet and x-ray telescopes. An instrument called "Sigma," which has a mass of 1 ton, has been developed by France's Nuclear Research Center for "Granat." The first object scheduled for observation with "Granat" and "Gamma-1" will be the supernova which flared up in the Large Magellanic Cloud in 1987.

R. Syunyayev, corresponding member of the USSR Academy of Sciences, commented on observations of x-radiation of this supernova with the "Rentgen" observatory on the "Mir" complex's module "Kvant." Formation of iron as the result of the explosion of a supernova has been confirmed experimentally for the first time as a result of these observations, for example.

Mentioned in conclusion is a project called "Alissa," which is to begin in 1991. A lidar unit for studying the upper portion of the Earth's cloud cover will be installed on "Mir" in line with this project.

Soviet-French Cosmonaut Missions Every Two Years, Further Space Cooperation Planned

18660069 Moscow PRAVDA in Russian 30 Nov 88 p 8

[Article by A. Pokrovskiy]

[Excerpt] When Jean-Loup Chretien departed for the "Mir" station with his Soviet colleagues, he didn't know that this flight would mark the opening of regular Soviet-French space navigation. During French President F. Mitterand's visit to the Soviet Union, agreement was reached that another Soviet-French crew would work in orbit every two years. Word of this agreement reached Chretien when he was aboard the station.

I. Reva, program management director of France's National Center for Space Research, briefed journalists on the most promising Soviet-French projects. Two of them are in the field of extra-atmospheric astronomy. The first calls for launching a Soviet satellite equipped with a French telescope called "Gamma," which will be used to observe gamma-ray sources with high energies. In line with a project called "Granat," a French telescope, "Sigma," will be employed on a Soviet satellite. This telescope is intended for searching for low-energy x-ray and gamma-ray sources.

Apparatus called "Skarabey," which is intended for studying the radiation balance of the "Earth—atmosphere" system, will go into orbit on board a Soviet "Meteor" satellite in the early 1990s.

Lastly, a flight to within 1,000 kilometers of six to eight asteroids is envisaged in line with a project called "Vesta." Longer-term programs also exist, particularly ones for research of the planet Mars.

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